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THE

POLYZOA OF THE SIBOGA EXPEDITION

BY

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PART III

CHEILOSTOMATA ASCOPHORA. I

FAMILY RETEPORIDAE

With 7 plates and 25 text-figures

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PART III

CHEILOSTOMATA ASCOPHORA. I

Family RETEPORIDAE

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I. INTRODUCTION.

The Reteporidae, a Family which I restrict to the species mostly included in the genera *Retepora* and *Reteporella* of previous authors, are well represented in the Siboga Collection. Their study involves special difficulties, in view of the substantial alterations, due principally to secondary calcification, which occur during the growth of a colony. Descriptions which have been based respectively on the evidence of younger and older conditions are thus in many instances not strictly comparable. Further difficulties result from the fact that the most characteristic features of a species may not be represented in the portions mounted for microscopical examination, or may fail to develop in any part of the colony. The determination of specimens frequently has to rest on the recognition of merely a small proportion of the characters which are distinctive of the species.

In studying the Retepores of the Expedition I have had the special advantage of access to important specimens which have a direct bearing on the Siboga Collection. The 'Challenger' species described by BUSK, including his type-specimens, are all in the British Museum, with many others important in the present connexion. The collection of the University Museum of Zoology at Cambridge (see Part I of this Report, p. 3) has proved invaluable, particularly the following parts: —

(*a*) an extensive series of Victorian specimens from Miss JELLY's Collection, received by her from P. H. MACGILLIVRAY;

(*b*) Dr A. C. HADDON's Collection (part of which is in the British Museum), from Torres Straits;

(*c*) specimens from Singapore, presented by various donors;

(*d*) the OWSTON Collection, with other material, from Japan.

As in the case of species described in Part II of this Report, Cambridge specimens which are to be transferred to the British Museum (Natural History) are indicated by the letters BM.

I have to acknowledge my special indebtedness to Dr A. B. HASTINGS, who has spared no trouble in facilitating my access to specimens in the British Museum and has discussed with me various questions on which her opinion was valuable; to Mr H. G. HERRING, also of the British Museum, who prepared the beautiful series of photographs reproduced as Plate XXXV; to the Manchester Museum for the loan of the type-specimens of *Retepora bilaminata*; and to Dr C. H. O'DONOGHUE for the loan of the type-specimen of *R. gilchristi*.

The method of giving references is that explained in Part II of my Report (p. 186).

In the two earlier Parts of my Report, the Stations were arranged, under the respective species, in their numerical sequence. With Professor WEBER's consent I have adopted a different system in the present Part, as giving a better indication of the distribution in the Archipelago. The Stations are here arranged in their geographical order, under the following groups: —

Group A. — Java and Flores Seas, and Southern Islands to W. end of Timor; as far as possible from W. to E.

Group B. — Celebes Sea and Sulu Archipelago.

Group C. — W. end of New Guinea to E. end of Timor.

The Strait of Makassar has been singularly unproductive of Retepores; and the entire Banda Sea produced only two members of this Family.

I take this opportunity of expressing my warmest thanks to Professor WEBER for his unfailing kindness in all matters connected with the preparation of the three Parts of this Report.

Among the general results of the present study I may call attention to the following;

(*a*) A recognition of the great changes which take place during growth, mainly as the result of secondary calcification.

(*b*) New information with regard to the ancestrula and the initial stages of the zoarium, in *Iodictyum* and *Triphyllozoon*.

(*c*) Confirmation of CANU and BASSLER's conclusion that the characters of the ovicell are specially important in defining genera.

(*d*) Establishment of the strikingly distinct features of *Iodictyum*, introduced in a preliminary account (1933) based on the present material.

(*e*) The importance of the avicularia, and particularly of the infrafenestral and other fenestral avicularia, as specific characters.

(*f*) Re-definition of nearly all the Malayan species described by BUSK in the 'Challenger' Report.

A. TERMINOLOGY.

(Additional to that published in Part II, pp. 184—186.)

Ancestrula. — The primary zooecium (see pp. 507—511), formed by the metamorphosis of the larva (JULLIEN, 1888, Miss. Sci. Cap. Horn, VI, Bryozoaires, pp. 27, 29).

Antenniform spine. — A jointed spine in which each segment widens distally.

Basal plate. — The calcareous base attaching the zoarium to its substratum.

Cryptocyst. — See Part II, p. 185.

Descending lamina. — The part of the frontal wall of the ovicell which descends into the peristome (p. 522).

Ectooecium. — See Part II, p. 185.

Entooecium. — See Part II, p. 185.

Fenestrae. — The window-like openings of the zoarium in reticulate species.

Frontal shield. — The calcareous frontal wall of a zooecium, underlying the uncalcified frontal membrane (HARMER, 1902, Quart. J. Micr. Sci., XLVI, p. 282. n.).

Gymnocyst. — See Part II, p. 185.

Kenozooecium. See Part II, p. 185.

Labellum. — The free tongue of the descending lamina of the ovicell (p. 522, text-fig. 27, *Lab.*). (JULLIEN, in JULLIEN and CALVET, 1903, BCH, p. 58; „labelle" or „labelle ovicellien").

Labial groove. — A median groove on the outer side of the proximal wall of the peristome, ending in the labial pore (p. 518, text-fig. 25 E, *l. g*, p. 519).

Labial pore. — A median or submedian pore on the proximal wall of the peristome, resulting from the closure of the labial sinus (text-fig. 25 C, E, *l. p*).

Labial sinus. — The proximal median or submedian sinus of the peristome (text-fig. 25 A, *l. sin*).

Labial suture. — An external suture connecting the labial pore with the edge of the peristome (p. 518, text-fig. 25 C, *l. sut*), resulting from the partial closure of the labial sinus.

Labial tube. — A longitudinal tube leading from the labial pore, presumably communicating with the compensation-sac (p. 520, text-fig. 25 G, *l. t*). See Sinus-groove.

Lateral flanges. — The proximal lateral continuations of the frontal wall of the ovicell into the peristome (p. 522, text-fig. 27, *L. Fl*) (HARMER, 1933, GR, p. 624).

Lateral sinuses. — The two bays at the sides of the median carina of the ovicell in *Iodictyum* (p. 522, text-fig. 27, *L. sin*) (HARMER, *ibid.*, p. 624).

Lateral slits. — A pair of slits at the sides of the labellum or (in *Iodictyum*) in the basal wall of the lateral sinuses (p. 522, text-fig. 27, *L. sl*) (HARMER, *ibid.*, p. 624).

Lyrula. — A median tooth (text-fig. 25 F, *l*, p. 519) on the proximal side of the peristome, situated externally to the operculum (JULLIEN, 1888, Miss. Sci. Cap. Horn, VI, Bryozoaires, p. 52).

Marginal denticles. — Minute teeth projecting into the cavity of the peristome (p. 508, Pl. XXXVI, fig. 2, *M. d*).

Marginal teeth. — Tooth-like prolongations of the edge of the orifice of the peristome (p. 508, Pl. XXXVI, fig. 2, *M. t*).

Marginal valleys. — The valleys between the septal ridges and the frontal shield of a young zooecium (p. 515, Pl. XXXVI, fig. 16, *M. V*).

Munitiform avicularium. — An enlarged modification of the small round avicularium, with powerful muscles, the orifice much wider than long, the mandible of similar form and highly chitinized (Pl. XLI, fig. 17, *M. av*). (HARMER, 1933, GR, p. 622).

Peristomes, fertile. — Those peristomes, in species with dimorphic peristomes, in which the distal wall is wanting. The ovicells are invariably developed on zooecia thus provided, although other zooecia of the same kind (regarded as potentially fertile) fail to produce them (p. 521).

Peristomes, ordinary. — Peristomes, in dimorphic species, without a distal deficiency (p. 521).

Sclerite. — A thickened line of the chitin of an operculum or mandible.

Septal lines. — The frontal lines which delimit the zooecia, sometimes originating as septal ridges, the height of which is reduced by secondary calcification (p. 515).

Septal ridges. — Calcareous ridges outlining the young zooecia, in certain species (p. 515; Pl. XXXVI, fig. 16, *S. R*).

Septulum. — A form of rosette-plate, generally uniporous, traversing the calcareous wall separating two zooecia (JULLIEN, 1888, Miss. Sci. Cap. Horn, VI, Bryozoaires, p. 42, as

septula); in Reteporidae represented also by pores in the outer wall of a marginal zooecium or kenozooecium and opening into a fenestra (p. 517).

Sinus-denticles. — The two marginal denticles, often stronger than the others, which delimit the peristomial sinus (p. 508; Pl. XXXVI, fig. 2, *S. d*).

Sinus-groove. — A longitudinal groove, on the inner wall of the peristome, connecting the external sinus (presumably) with the compensation-sac (p. 519, text-fig. 25 D, *S. g*); in some species closing to form a labial tube (*q. v.*).

Sinus-lobes. — One or two projections (usually triangular) of the peristomial wall, by which the original sinus is closed to form a labial pore (p. 595, text-fig. 25 B, *s. l*).

Sinus-ridges. — The two ridges which limit or define the sinus-groove (p. 519, Pl. XXXVII, fig. 7).

Spiramen. — A median pore on the proximal wall of the peristome, leading into its cavity (text-fig. 25 B, *S*, p. 519). (Jullien, in Jullien and Calvet, 1903, BCH, pp. 13, 59, 75).

Stigma. — The frontal fissure, usually linear or trifoliate, of an ovicell (text-fig. 35 A, p. 590).

Trabeculae. — The branches which separate the fenestrae, in reticulate species.

Vibices. — The lines, more or less projecting, which delimit the kenozooecia of the basal and frontal surfaces.

B. Nomenclature and Classification.

I have recently published (1933, GR) a chronological list of the genera which have been referred to the Reteporidae, with an indication of their respective genotypes; introducing at the same time two new genera, *Iodictyum* and *Reteporellina*, based on the present material. I do not here discuss the affinities of the Reteporidae to other Cheilostomata, nor the systematic position of certain encrusting genera which have been placed in the Family by various authors. The characters of the opercula have not proved very helpful in the discrimination of closely allied species, but I have found those of the avicularia and their mandibles more useful, particularly in *Triphyllozoon*.

C. Methods.

The characters of specimens of Reteporidae cannot be satisfactorily ascertained without removing the delicate organic membrane by which both surfaces are covered. Eau de Javelle is specially useful for this purpose; but even after this treatment the zooecia, of young specimens at least, often remain so vitreous and semitransparent that their surface-ornamentation is observed with difficulty. The method of calcination or raising fragments to a red heat, as adopted by Waters and others, is invaluable, since it renders the calcareous parts white and opaque. Specimens thus treated are liable to deterioration, and some of my earliest preparations have unfortunately had this fate. The granular encrustation which sometimes spoils the specimens may be removed by brushing with dilute formalin. Specific characters are often best marked in young zooecia; and these should always be examined if possible; in addition to older parts of the same colony. In view of the importance of examining both surfaces, there are great advantages in using glass-backed slides, and I have employed this procedure for nearly all my later mounts.

Canada balsam preparations of opercula and mandibles are practically essential in certain species, particularly in those of the very difficult genus *Triphyllozoon*. The determination of Retepores without microscopical examination is unsatisfactory. I have found it necessary to mount dry fragments of every colony obtained; and I have made preparations of the chitinous parts of practically all the specimens of *Triphyllozoon* except of those in which the material was very scanty.

D. Zoarium.

(*a*) Early growth and form of the Reteporidan colony.

The earliest stages are at present very imperfectly known. Hincks (1880, BMP, text-fig. 18 on p. 394) reproduced a figure originally published by Busk (1859, FPC, Pl. XXII, fig. 4*a*), under the name of *Lepralia lobata*; and stated, no doubt correctly, that this was a young *Retepora* which well illustrated the mode of growth. It may be inferred from his comments that he supposed the formation of a central group of kenozooecia to precede the development of ordinary zooecia. Levinsen (1902, SB, p. 24) showed that Hincks' presumed interpretation was incorrect, and that the colony commences as a single zooecium; basal kenozooecia not appearing until it has reached a certain size. Some two years later Cumings (1904, DPB; 1905, DF), who had probably not seen Levinsen's paper, gave a brief indication of the initial stages of *Iodictyum phoeniceum* from South Australia. He figured the ancestrula (1905, Pl. VI, fig. 28) as a Cyclostome-like zooecium with a circular orifice, giving rise to three distal successors, one median and two lateral. In 1909 Levinsen (MSSB, p. 291, Pl. X, figs 1, *c*—*h*) described and figured very young colonies of *Sertella beaniana*. The youngest (1, *c*) consisted merely of the ancestrula, two other complete zooecia and two more, still immature. The ancestrula was "in the *Membranipora* stage"; and, as shown by the figures, it was quite short, the opesia being surrounded by a complete circlet of 8 or 9 spines, represented by their bases. In the next stages the colony gave rise to a layer of zooecia which early became free, to form the first trabeculae; and also to a basal supporting expansion encrusting the substratum and consisting of kenozooecia, some of which carried avicularia. Levinsen did not indicate the mode of formation of the frontal kenozooecia which later obliterate tne older zooecia; but he stated that kenozooecia ultimately occur on both basal and frontal surfaces of the colony (see his explanation of Pl. X, figs 2, *b*; 2, *c*).

Levinsen and Cumings thus described ancestrulae unlike in their characters. They were dealing, however, with different genera; and it would have been unsafe to predict from their accounts the general character in a species belonging to neither of these genera. In this state of uncertainty it might not be possible to recognize an ancestrula as Reteporidan.

I have been fortunate in obtaining evidence on this subject, from very young specimens which can respectively be referred, certainly or with a high degree of probability, to species of *Iodictyum* and *Triphyllozoon*; and it indicates that both Cumings and Levinsen were substantially correct. A solitary ancestrula of *Iodictyum* (Sect. A) is recognizable as Reteporidan by its brilliant colour; which is, moreover, a great aid to the discovery of these minute objects.

(I) *Iodictyum projectum* (see p. 550).

The two minute colonies, 388. E, are probably but not certainly referable to this species. The younger one (Pl. XXXVI, fig. 2) is at least as young as that described by Levinsen, and

it is in beautiful condition, standing out as a brilliantly carmine object on the pure white background of a Nullipore. It consists of 3 complete zooecia, with another of Membraniporine appearance. The last is either the incompletely developed fourth zooecium; or, perhaps, the first of the basal kenozooecia. By comparison with other very young colonies, it is obvious that A is the ancestrula; and on this assumption the young colony essentially resembles that described by CUMINGS in the same genus. The ancestrula has a proximal, calcified frontal shield (A) and a long, complete, tubular peristome expanding towards the orifice, the edge of which is slightly crenulate and is prolonged into 4 prominent, triangular, acutely pointed "marginal teeth" (*M.t*) which are actually more vertical than in the figure. "Marginal denticles" (*M. d*)project into the peristome, one from the base of each tooth; and the two proximal ones are the "sinus-denticles" (*S.d*) which delimit the sinus in this and certain other Retepores. The denticles, as in other zooecia, are the exposed ends of internal longitudinal ridges which pass longitudinally down the inner side of the peristome.

The ancestrula has given rise to two distal successors, each with a pair of sinus-denticles on the side nearest the ancestrula. The apparent right distal zooecium (the sides are reversed by the microscope) has 3 or 4 marginal teeth. Its sinus is well marked, and the sinus-denticles are stronger than the other 7 denticles (*M.d*). The left distal zooecium has fewer denticles.

Another colony (fig. 3) on the same slide consists of 19 zooecia, and has developed the bases of 4 triserial trabeculae, still without anastomoses. A few marginal kenozooecia are present, forming the commencement of the basal plate of attachment. The ancestrula (*A*) is recognizable by its central position and by its resemblance to that of the younger colony. Its peristome has become shorter, by immersion due to the growth of its neighbours. The edge of its spreading orifice is prolonged into 7 strong marginal teeth, with internally projecting denticles; and the sinus-denticles are slightly stronger than the others. Two of the zooecia are in nearly the same position as in the younger colony, the right one with no marginal teeth, the left one with about 6 teeth like those of the ancestrula, with the accompanying denticles. The ancestrula is surrounded by a circlet of 6 zooecia, in most of which marginal teeth and denticles, including the sinus-denticles, can be recognized. In the remaining zooecia (not figured) marginal teeth are evanescent or absent, but there are generally 6 denticles, one of the younger zooecia having merely the two sinus-denticles.

All the peristomes of these two colonies are long and tubular. In the earliest zooecia, including the ancestrula, the everted margin is produced into marginal teeth; and internal denticles are present. As growth proceeds, a simplification of the orifices occurs; the marginal teeth being the first to disappear. The denticles are next reduced in number, leaving only a single pair in one of the youngest members.

A slightly older colony (469. B), probably belonging to the same species, was found on *Triphyllozoon inornatum* (slide 469. A). Its peristomes agree well with those of 388. E, as shown in fig. 3.

(II) *Iodictyum phoeniceum* (see p. 541).

The Cambridge collection includes four young colonies which further elucidate the characters of the ancestrula in *Iodictyum*. Three of these, part of a collection sent by Sir J. C. VERCO

from Adelaide, can be determined, not only by their locality but also by positive characters. One shows the frontal avicularia distinctive of the species, and in all of them most of the peristomes have closed labial pores.

One of the two younger colonies is subcircular, 2 mm. in diameter, and consists of about 20 mature zooecia, with the commencements of other zooecia or of marginal kenozooecia. The centre (Pl. XXXVI, fig. 4) is occupied by the ancestrula surrounded by 6 derivatives, one or two of which have peristomes with expanding orifices, the margin more or less toothed. The ancestrula has obscure marginal teeth and internal longitudinal ridges not ending as distinct denticles; and a nearly closed peristomial sinus is present. Of its successors, one at least has a wide sinus, with indications of internal longitudinal ridges. The remaining zooecia have closed labial pores and obscure crenulations or denticulations of the orifice. The margin of the colony consists of Membraniporine units, the commencements of zooecia or of kenozooecia for attachment.

A slightly later colony, of rather more than 30 zooecia, also shows a central group, consisting of the ancestrula, now almost completely immersed, immediately surrounded by 6 others; and all of these have, more or less distinctly, the characters of the oldest zooecia of the preceding colony. The later zooecia have slightly crenulate or toothed peristomes and closed labial pores. Several complete attaching kenozooecia occur marginally; and on two of these there is an avicularium resembling the frontal avicularia normal for *I. phoeniceum*.

A third colony on the same slide is 5 mm. across. Seven trabeculae are indicated, rising at first as slight ridges of the central encrusting part, but several have become free basally. Parts of the trabeculae have been lost, and it is uncertain whether fenestrae had been formed. The erect portion is surrounded by a zone of large shallow kenozooecia, each bearing, near its outer extremity, a median avicularium which resembles the frontal avicularia of this species; its acute rostrum directed radially outwards or distally. The marginal teeth of some peristomes in the central group are still visible, although the zooecia have become partially immersed. The orifice of at least one of them is completely occluded by a calcareous film which is so delicate that it has not completely smoothed out the marginal teeth. The other secondary orifices remain open; but in several the orifice is occupied by a tube of the Infusorian *Folliculina*. It may be inferred that these at least had lost their polypides and that they would also have been occluded in their turn. The colony is thus of interest in showing the commencement of the process by which the central frontal region, and later the corresponding surface of the trabeculae, become covered by a layer of kenozooecia.

The shape and size of the frontal kenozooecia of Reteporidae are very irregular, and the exact way in which they develop has not been ascertained. Their edges are of the same nature as the vibices of the basal surface. When fully developed, the frontal kenozooecium may have a definite outline, but while growing the edge or vibex may be distinct in one part, continued as a thin line or low ridge over the pre-existing calcareous surface, and gradually dying away where development has not proceeded so far. The complete frontal kenozooecia in this colony are mostly regular in shape, rather longer than wide, ovoid, subhexagonal or of other forms, and not differing greatly in width from the zooecia. They are arranged without any reference to the position of the zooecia, and one of them has developed an avicularium of the kind produced secondarily in this species (see p. 525).

(III) *Iodictyum polycrenulatum* (see p. 556).

The central parts of 459. O (Pl. XXXVI, fig. 5), a young colony 7 mm. across and in excellent condition, agree well with those of *I. projectum*, as described above. The ancestrula and some of its immediate derivatives have expanding peristomial orifices, prolonged into large marginal teeth, and the marginal denticles are highly developed. The trabeculae rise directly from a small basal plate, the widely open cup formed by the zoarium being developed on one side only.

(IV) *Iodictyum gibberosum* (see p. 559).

Two very young colonies, respectively 2 and 3 mm. in diameter, are described on p. 560.

(V) *Triphyllozoon hirsutum* (see p. 594).

I have obtained initial stages of the growth of the zoarium from several localities. The best material (Singapore), sent by Dr R. HANITSCH to the Cambridge Museum, consists of a number of young colonies growing on a Sertularian Hydroid. These form a continuous series, from a stage with only 9 zooecia, including the ancestrula, to a relatively large colony, 14 mm. across.

As illustrated by text-fig. 24, one of the youngest colonies, about 0.6 mm. in diameter and consisting of 9 units, has a *Tata*-like ancestrula closely resembling that of *Sertella beaniana* shown by LEVINSEN (1909, MSSB) in Pl. X, fig. 1*c*; the only difference being the occurrence of a median keel on its proximal part. The opesia is circular, and 9 spines can be distinguished; — 4 on the distal edge of the opesia and 5 at the margin of the proximal part. The opesia seems to have been at first co-extensive with the entire frontal surface, its proximal part having been calcified as a cryptocyst (*Cr*) which reduced its extent; — a conclusion confirmed by the presence of a median suture on the carina. The ancestrula is surrounded by 5 complete zooecia, and there are 3 others (Z^6—Z^8), not yet fully developed. Z^6 shows the operculum (*Op*) surrounded by the commencement of the peristome. Z^7 also shows its operculum, but the proximal margin of the commencing peristome has an asymmetrical sinus (see p. 519). Z^8 has a flat frontal membrane, at present uncalcified.

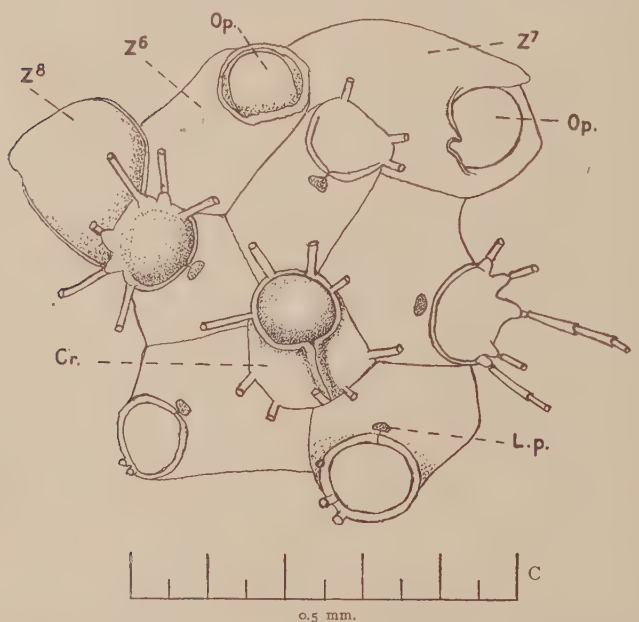

Fig. 24. — *Triphyllozoon hirsutum*. Young colony, consisting of the ancestrula and 8 other zooecia (see text). Mus. Cambridge, Singapore, Hanitsch Coll., A[1]. *Cr.*, cryptocyst of the ancestrula; *L.p.* labial pores, seen on descending surfaces and therefore foreshortened; *Op.*, operculum; Z^6—Z^8, zooecia of the distal part of the growing marginal zone, Z^8 still completely membranous (but perhaps a marginal kenozooecium) and flat in front. The peristomial orifices of some of the zooecia are broken and are represented conventionally. Obj. *C*.

It is noteworthy that although *T. hirsutum* typically possesses a sinuate peristome, the 5 zooecia surrounding the ancestrula have closed labial pores (*L.p.*). Long jointed spines occur on some of the zooecia, and one or two are antenniform, in contrast with the oldest colonies of the same

material, in which the longest spines are only obscurely jointed. The full number of spines, except in the ancestrula, appears to be 3 : 3, a conclusion confirmed by other specimens. Two other colonies of about the same age have been found, each with an open ancestrula and 5 encircling zooecia; but in one slightly older the ancestrula appears to be surrounded by only 4 zooecia.

A colony about 3 mm. in diameter has completed the first 6 fenestrae. The ancestrula is still open and some of the spines are antenniform. Nearly all the peristomes have a closed labial pore, but one or two situated peripherally have an open sinus. Labial and small frontal avicularia are not uncommon. In some of these young colonies, the ancestrula is becoming concealed by the thickening and overgrowth of its derivatives. Its spines are no longer visible, a result apparently due, sometimes at least, to their inclusion in the thickening walls of the surrounding zooecia. The ancestrula is now recognizable as a deep central circular depression, corresponding with its opesia; and in this state it can often be recognized, as in other species, in moderately large colonies. Sooner or later it becomes completely overgrown, but the zooecia immediately surrounding it may still be apparent when it has been completely occluded. The details of the first formation of the kenozooecia of the basal plate have been described by LEVINSEN, but they are not easily seen, since they are generally concealed by the projecting edges of the zoarium. In some, but not all, of the young colonies, the trabeculae are delicate and biserial, in contrast with the stouter ones of older specimens.

544. F, from the Siboga Collection (Pl. XXXVI, fig. 1) is in about the same condition as the youngest colonies from Singapore. It consists of the ancestrula, surrounded by 6 zooecia, with 3 others which appear to be growing out to form the first trabecula. It shows 3 pairs of antenniform spines and the closed labial pores characteristic of early stages. As in the Singapore specimens, the frontal wall of the ancestrula has a median carina. Small round avicularia are already present on the other zooecia. 297. C includes a similar colony, with antenniform spines; and another rather older. Both have an open ancestrula, which has a median keel in the younger one.

It seems to be established by the above facts that generic differences in adult structure may be correlated with differences in the ancestrulae. A sufficient amount of evidence has been obtained to show that in the characters of the ancestrulae *Iodictyum* has no close resemblance to *Triphyllozoon*. An extreme advocate of the recapitulation hypothesis might even suggest a diphyletic origin of the Reteporidae, on this ground. I believe, however, that the Family is a natural one and that the numerous characters the Reteporidae have in common are not to be explained on such a view. It seems more probable that the ancestrulae and their immediate derivatives obtained their distinctive features *pari passu* with the evolution of others which characterize the remaining units of the colony.

The evidence of a number of young specimens, of many species, points to the conclusion that the colony of a fenestrate Retepore is at first cupuliform or saucer-shaped, with the orifices on the upper or concave side. This form may be retained throughout life (Pl. XXXV, fig. 34); the cup sometimes growing to a large size; but, although concave centrally, often expanding into lobes which are in some species nearly flat (Pl. XXXV, fig. 24), in others wavy or folded. In many species the wave-like elevations or depressions unite with one another, thus forming

closed tubes which subdivide once or more, each division being preceded by an expansion of the tube into a regular or more or less flattened funnel (Pl. XXXV, fig. 25). If the lobes unite by their frontal surfaces, the orifices of the zooecia are on the inner side of the resulting tube, as in fig. 25; but if by their basal surfaces, on the outer side. Busk correctly called attention to the fact that *Triphyllozoon philippinense* differs from certain other species in having external orifices. The position of the orifices, whether external or internal, is in fact a useful specific character in this genus. When the zoarium is completely tubular I have found hardly a single exception to the rule that in certain species the orifices are internal and in others external. Other species are much waved or convolute, anastomosing in an irregular manner without forming a tubular zoarium (Pl. XXXV, figs 2, 32). Tubular portions may sometimes be isolated from a colony of this kind, some with external and others with internal orifices. In some species it appears that two different types of zoarium may occur. Of the specimens I have referred to *T. hirsutum* some have retained the primitive cup-shaped form, growing to a large size in that condition (Pl. XXXV, fig. 24), while others have become completely tubular, with external orifices.

It is probable that there may be some correlation between the form of the colony and that of its substratum. The nature of the latter is generally unknown, the specimens being commonly torn from their attachment by the dredge. The saucer-shaped condition is obviously suitable for a colony which grows on a large flat surface, although it is not necessarily restricted to that form of substratum. An interesting mode of formation of the tubular condition with external orifices is shown by certain specimens, of *T. hirsutum* and *T. trifoliatum*, which have grown completely round the delicate axis of a Hydroid or of an Alcyonarian, to which they are attached. The colony is centrally saucer-shaped, or this part may be from the first flat or even slightly convex frontally. Its folded margins have been reflexed and their lobes have united by their basal surfaces, thus forming a system of more or less radiating tubes with external orifices, together constituting a subspherical zoarium traversed by the axis on which the ancestrula must have attached itself.

In *Reteporella* (Pl. XXXV, figs 12—15) and *Reteporellina* (figs 19—23) the zoarium is "ramose", often with no anastomoses between the branches. In other specimens these occur; but although the distinction between ramose and fenestrate specimens, in these genera, is not always sharply marked, the fenestrae (if present) of the ramose colonies are generally more variable in form and size than in a typically fenestrate colony, in which they are relatively uniform in shape. Certain genera, *e.g. Triphyllozoon*, seem to be invariably fenestrate. *Iodictyum* is almost equally constant in possessing this character, but *I. spicatum* (Pl. XXXV, fig. 8) has a ramose zoarium.

(*b*) Bilaminar Retepores.

With very rare exceptions the zoarium of Reteporidae consists of two layers; — the frontal series of ordinary zooecia and the basal series of kenozooecia. It would naturally be supposed that a Retepore is an erect modification of a unilaminar encrusting sheet, but Buchner (1924, UJR, p. 181) has expressed the opinion that these forms were originally bilaminar, the basal layer of zooecia having degenerated to kenozooecia. On p. 171 he cites two known

instances of the occurrence of a bilaminar condition, in *Retepora bilaminata* and *R. tessellata* respectively.

R. bilaminata, from South Africa, was described by WATERS (1904, BB, p. 78), his specific name being given on pp. 103 and 110. The type-material, which has been kindly lent to me by the Manchester Museum, consists of various slides and of two unmounted pieces; — (I) a nearly circular, saucer-shaped piece, about 25 mm. in diameter; (II) a flat, massive, bilaminar lobe, about 40 mm. long and 25 mm. wide. There is no evidence that these were parts of the same colony, but this may have been the case and they undoubtedly belong to the same species. Although neither shows the slightest external resemblance to a Retepore, nor any trace of fenestrae or branches, WATERS rightly referred them to *Retepora*. The circular piece was obviously attached by a thick but very short calcareous stalk, in the middle of its slightly convex basal surface; and there are indications that it was also supported by several smaller calcareous outgrowths of the same surface. This is covered by slightly convex kenozooecia, with a few pores but no avicularia, and is outlined by weak vibices. Its other surface (frontal), composed of old and worn zooecia, is concave, with several irregular but more or less radiating ridges running inwards from the margin. Parts of the edge are of the usual Retepore character, consisting of a basal layer of kenozooecia and a frontal layer of ordinary zooecia. At the point of origin of a radial frontal ridge, the edge consists of several tiers of cavities; and, nearer the centre, the ridge is a definitely bilaminar fold, each face being composed externally of a layer of zooecia continuous with that of the surface from which it rises, and internally of a cancellated portion which may be regarded as composed of thin-walled, hollow kenozooecia.

The structure of the flat piece suggests that the ridges of the central part probably continued to grow as bilaminar plates, although the form of the colony cannot be reconstructed from the two fragments. The short zooecia of this piece are outlined by moderately distinct septal lines and are in good condition; their structure being shown in Pl. VI, figs 8*a*, 8*b* of WATERS' memoir. The labial avicularia are small, projecting in such a way as to give rise to a unilateral sinus-like extension of the peristomes. The frontal avicularia are superabundant, minute and oval, each almost equally divided by its calcareous bar. I agree with WATERS' estimate that the average number on a zooecium is about four. Part of the surface is overgrown by frontal kenozooecia, on which are numerous small avicularia. The ovicells are Reteporidan, subglobose, with a narrow median fissure, the descending portion fairly steep but not terminating in a definite labellum. WATERS stated (pp. 78, 79) that his Victorian specimens of *Retepora granulata* had zooecia and ovicells "exactly similar" to those of *R. bilaminata*. My own examination of *Sertella granulata* (see p. 566) from the same locality (and, I feel sure, correctly determined) convinces me that the resemblance is no more than generic, the ovicells being very different from those of *R. bilaminata*.

As shown by the above account, the part which appears to be the central and oldest portion of the colony of *R. bilaminata* consists of a single layer of frontal zooecia, backed by a layer of typical basal kenozooecia. The bilaminar lobes are secondary.

The zooecial characters of *Retepora gilchristi* described by O'DONOGHUE (1924, BPP, p. 49), agree closely with those of *R. bilaminata*. The two supposed species were based on material from the same locality (South Africa) and it thus appeared desirable to compare the original

specimens. I have been able to do this by the kindness of Dr O'Donoghue, who lent me his type-specimen of *Retepora gilchristi*. I find that his description is very satisfactory and that this species resembles *R. bilaminata* so exactly in all essential characters except zoarial form that there are reasons for supposing the two to be synonymous. I did not find the large avicularia described by O'Donoghue, but this seems to be unimportant. In the form of the ovicells, with their median fissure, and in the exceptionally numerous small round avicularia of the frontal surface, the agreement is complete. Another signifiant detail is that in both species there is a large transverse labial avicularium within the proximal margin of the secondary orifice, facing distally, and resulting in the displacement of the minute sinus to one side. The type of *R. gilchristi* is a fine specimen, nearly flat, slightly pink in colour, and about 52 mm. in greatest length. The trabeculae are much wider than the fenestrae, 5—6 serial on the average, but wider (up to at least 12 rows of zooecia) on the proximal sides of certain fenestrae.

It seems to me probable that *Sertella bilaminata* (Waters), which I refer to this genus owing to the median fissure of its ovicell, is an unusual growth-form of a species which is normally constructed when it has the form found in *Sertella gilchristi* (O'Donoghue).

In 1884 Busk (Chall., p. 114) introduced a new species, *Retepora escharoides*, the locality of which was unknown, and remarked that its opercula and mandibles are "exactly those of *Retepora tessellata* and its varieties". Except for this statement and the information that *R. escharoides* is bilaminar and like an *Eschara*, he gave no indication of its characters. He stated that the material was in the Oxford Museum; but Waters (1904, BB, p. 78) was unable to find it there. It may be assumed, however, that it had been transferred to the British Museum, where it is now preserved as seven or eight specimens which were part of the Busk Collection. A large piece, 35 mm. long and 29 mm. wide, found undetermined in that Collection, is bilaminar in every part; and, as stated by Busk, it is completely Escharine in appearance. It consists of a series of wide, nearly vertical tubes, 7—10 mm. or more in diameter, with no interspaces; and some indication of its probable mode of formation is suggested by the bilaminar ridges described above in *Sertella bilaminata*. The ovicells are widely emarginate, like those of *Retepora tessellata* Hincks, the genotype of *Schizoretepora*. The close agreement between the two forms, in all respects except zoarial characters, is a sufficient reason for referring to it as *Schizoretepora escharoides*, although I think Busk was right in suggesting that it is probably a variety (or growth-form) of *S. tessellata*. One of his slides fully confirms his statement that the opercula and mandibles of *S. escharoides* are indistinguishable from those of *S. tessellata*, illustrated by him in figures of two varieties on p. 113 of the 'Challenger' Report. The sclerite of the operculum, indented on each side and of the form characteristic of *Schizoretepora*, is specially noteworthy. The sinuate peristome, the ovicells and the frontal avicularia, including many of the characteristic small acute type and others of larger size, much raised and with strongly beaked rostra, are alike in both forms; which are practically identical in all except zoarial characters.

Levinsen (1909, MSSB, p. 293, Pl. X, fig. 4*c*) stated that the zoarium of *S. tessellata* is sometimes bilaminar. I have found evidence (Mus. Cambridge) that in this species two adjacent lobes of a colony may meet, back to back, and finally anastomose, the fenestrae of the two lobes coinciding with one other; and I have reason for believing that a similar condition may occur in other species. This is merely a partial concrescence which does not affect the growth

of the entire colony, as in the bilaminar forms above described. The facts here considered do not seem to support BUCHNER's suggestion that the Reteporidae were originally composed of two layers of ordinary zooecia.

(*c*) Alterations in zooecial and other characters with advancing age.

The free distal margins of a normal Retepore are composed of new, developing zooecia; and since many of the characteristic features of a species are best seen in young units of the colony, it is always desirable to examine this region. More proximally, extensive changes are taking place, due to secondary calcification, which begins with a general thickening of the calcareous walls. The peristomes, at first often thin-walled and projecting, become more or less immersed and almost level with the surface, but frequently remain as slightly projecting subcircular ridges distinct from the secondary calcification. The spines with which the young peristomes are often provided are generally lost; but their bases, 1 : 1 in the great majority of Retepores in which spines occur, often remain distinguishable for some time. The originally thin-walled ovicells become complicated by an additional covering which may materially alter their shape, and this commonly bears secondary avicularia.

Both surfaces of the colony are at first covered by a delicate organic membrane, which is generally raised above the surface by a number of tubercles on the primary skeleton, basally (Pl. XXXVII, fig. 27) or less frequently frontally (Pl. XXXVII, fig. 23). Secondary calcification is obviously due to the living tissue between the external chitinous layer of the membrane and the subjacent skeleton, which must be regarded as a cryptocyst. The changes which typically occur during growth may be illustrated by an account of these processes in *Iodictyum*.

The commencing zooecia (text-fig. 26, p. 522; Pl. XXXVI, fig. 16) are typically hexagonal in this genus, outlined by high and thin calcareous ridges which I call the "septal ridges" (*S.R.*). The frontal shield is convex and is produced into the wall of the raised peristome, the base of which fills most of the area bounded by the distal parts of the ridges. The primary orifice and the base of the future peristome occur well on the proximal side of the distal ridge. Between the outer parts of the frontal shield and the bases of the ridges are deep depressions which may conveniently be termed "marginal valleys" (*M.V.*); and it is on the median side of these valleys that the paired pores (*P*) found in *Iodictyum*, at first relatively small, make their appearance. The septal ridges do not long continue to project but are reduced to mere "septal lines" by the filling of the marginal valleys with secondary calcareous material; the pores remaining open and enlarging as they pass frontally, as in Pl. XXXVII, fig. 15. The completed pore is accordingly funnel-shaped, but two of the original pores are often connected with a single frontal opening. The central parts of the zooecium also increase in thickness, and the frontal surface becomes more or less flat. In *Triphyllozoon* and in other Retepores the young zooecia are from the first outlined by septal lines not sufficiently prominent to merit description as ridges.

In addition to the changes above indicated a further complication is introduced by the appearance of kenozooecia. On the frontal surface it is difficult to distinguish completely between mere thickenings of walls already present and alterations due to the development of new kenozooecia. These structures are clearly recognizable in some instances (text-fig. 32, D, p. 576), and they frequently produce avicularia which may differ in their size, shape and orientation from the

primary avicularia. But in any case the secondary calcification, by one or other of the methods indicated, eventually results in the complete occlusion of all parts originally produced at the growing margin. The last parts to be thus covered are the avicularia and the peristomial orifices. When the latter are occluded it is obvious that the active life of the corresponding zooecia must come to an end. No further polypides are developed, and the occluded proximal parts of the colony are reduced to a supporting base for the more distally placed functional individuals. The older regions become so highly calcified that there is little difference between the frontal and basal surfaces.

In some instances kenozooecia occur sporadically in groups on the frontal surface. Information with regard to their mode of development is given by an old fragment of *Iodictyum phoeniceum* (Port Western, Victoria) in the Cambridge Collection. A white calcareous film, at first so delicate that it has no definite edge, covers the brilliantly coloured zooecia. At this stage it has a finely reticular character, the meshes minute and irregular. Some of its strands are thicker and more definite than the rest; and these are the initial frontal vibices, which become more recognizable when calcification has advanced. They have no relation to the pre-existing pattern, crossing the original septal lines in any direction, although these may be used as parts of the boundaries of future kenozooecia. The only limitation which seems to occur is their relation to the frontal pores, on which they presumably depend for nutrition during their development. A young kenozooecium includes at least one pore, but as the boundaries of two contiguous kenozooecia are frequently wavy and do not completely coincide, a small area without a pore may occur between them. If two pores are present they do not necessarily belong to the same zooecium. With the continuation of the process, the kenozooecium, at first slightly concave, is filled in, and it becomes no more than a thin scale-like plate. The original pore diminishes in size, but its continuation may persist as a frontal pore in the completed structure. The arrangement of kenozooecia thus formed is entirely irregular, their outlines (vibices) being straight or sinuous. The amount of calcification is very variable, even in specimens from the same locality.

It is in most cases difficult to decide from superficial inspection whether the occlusion of zooecia is due to the formation of definitely circumscribed kenozooecia or to a more general thickening of the pre-existing calcareous parts. Levinsen (1909, MSSB, Pl. X, figs 2*b*, 2*c*) has figured sections of branches showing that layers of definite kenozooecia may occur on the frontal as well as on the basal surface of a Retepore.

The basal surface is from the first formed of a layer of kenozooecia which do not correspond with the zooecia of the frontal surface; their septal lines being the vibices. Near the growing margin the kenozooecia may be so thin that the outlines of the zooecia can be seen through them (text-fig. 48*s*, p. 629), showing that the pattern of the vibices is entirely different from that of the frontal septal lines. Similar evidence may be obtained by raising a fragment to a red heat, after which the zooecia may be isolated or separated from the basal layer, which shows impressions corresponding with their basal walls (Pl. XXXVIII, fig. 9). The terminal as well as the basal walls of the zooecia often split, after this treatment, into two layers; a result which does not agree with Levinsen's statement (1909, p. 292) that the terminal walls are single-layered in all Polyzoa except in the kenozooecia of Reteporidae and in the zooecia of *Onychocella*.

In *Iodictyum* the trabeculae are generally constituted, basally, of a biserial arrangement

of primary kenozooecia, each reaching one of the fenestrae (Pl. XXXVI, fig. 18); a more or less definite longitudinal vibex, straight or zigzag, occurring near the middle line of each trabecula in most species.

If parts of the longitudinal vibex are wanting, a kenozooecium may reach two or even three fenestrae (Pl. XXXVII, fig. 21). In other genera, as in *Triphyllozoon*, fewer vibices are present and a biserial arrangement of the kenozooecia is not apparent. At a level corresponding approximately with half the vertical thickness of the trabeculae, most of the frontal zooecia and of the basal kenozooecia (Pl. XXXVI, fig. 14) have 1 or 2 pores on their fenestral side. The two series of pores are close together, and the pores may be regarded morphologically as lateral septula.

As in the case of the frontal surface, it is often difficult to decide whether the continued thickening of the basal surface, when this occurs without alteration of the pattern of the vibices, is due to mere thickening of the basal walls or to the superposition of new kenozooecia; — and probably both conditions may occur. Sections in which the vibices are traceable through the entire thickness of the basal wall are figured by Waters (1904, BB, Pl. VI, fig. 6*a*) and Buchner (1924, UJR, fig. K, p. 177); and they suggest the former alternative. The stratification of the basal wall shown by Levinsen (1909, MSSB, Pl. XXIII, figs 2*b*, 2*c*) and in my own fig. 9 (Pl. XXXVIII) suggest the latter. Buchner (p. 183) did not find the condition indicated by Waters in erect parts, but he stated that it commonly occurs in the basal plate by which the colony is attached. Whatever the method of increase, the vibices generally become more prominent for a time, until growth has nearly ceased. In the oldest, proximal, parts of a colony, the tubercles are no longer present and the vibices are reduced or are not visible. Descriptions of the amount of prominence of the vibices as supposed specific characters are of little value unless some indication is given of the state of growth to which they refer; — and this information is commonly wanting. I have not found the basal vibices very helpful in distinguishing closely allied species.

In other instances there can be no doubt of the fact that secondary kenozooecia may be superposed on the primary set, in such a way as to obliterate the original vibices and to substitute an entirely new pattern. This condition is illustrated by Pl. XXXVI, fig. 24, in which the secondary kenozooecia are small and very irregular in size and shape. Like those of the frontal surface, they produce new avicularia and possess surface-pores.

According to Levinsen (1909, p. 292) a basal kenozooecium is a thin calcareous scale, sometimes in the main solid, but often enclosing an irregular cavity prolonged into one or more narrow tubes, each of which may open by a pore on the basal surface of its own kenozooecium, or may traverse a vibex and open on the surface of a neighbouring kenozooecium (Levinsen, Pl. XXIII, fig. 1*a*) or become continuous with its cavity. Figures of Buchner (1924, UJR, Pl. XV, figs 4, 6, Pl. XVI, fig. 5) show that the cavity may occupy the greater part of the kenozooecium or only a small proportion of it; and that two irregular cavities may occur in the same kenozooecium.

In a discussion of the changes which take place during growth, Buchner states (p. 173) that in young trabeculae of *Schizoretepora tumescens* the zooecia are triserial, the median ones with a large prominent avicularium (his Pl. XV, fig. 1); and that the basal surface has biserial

kenozooecia, each as a rule with a long avicularium (sometimes two), its cavity much smaller than the enclosing kenozooecium (fig. 4). The frontal surface of a more proximally situated branch has an entirely different appearance (fig. 5). The secondary orifices are more distant from one another; the outlines of the zooecia, which are now wider, have become more irregular, and there are two or even three avicularia in the region of a zooecium. I doubt whether the orifices had become more distant, as BUCHNER seems to imply. The figure might by explained by the assumption that, in the multiserial branch, numerous kenozooecia and avicularia had been secondarily developed, concealing (but not altering) the original septal lines, and occluding some of the peristomial orifices, so that those which remain are two or three times the normal distance apart. More proximally the peristomial orifices had disappeared and the avicularia were smaller and frequently immersed. On the basal side they became more numerous, smaller and more immersed in the proximal than in the intermediate region of the colony.

I have found some difficulty in understanding exactly what is BUCHNER's opinion with regard to the morphology of the basal kenozooecia and their avicularia. If I understand him correctly, the superposed cavities of the thickened basal plate belong to avicularia, the mandibles of which have been successively buried and can be found in sections. I presume he regarded basal areas in which no avicularia could be demonstrated as kenozooecia. In other instances, the whole of an area enclosed by vibices was considered an avicularium, although its mandible might not be visible if covered by a more superficial avicularium. BUCHNER believed that his view involves the assumption that an avicularium in Reteporidae can bud off another avicularium.

The distinction which I understand BUCHNER to make appears to be a rather shadowy one. When a kenozooecium has a single cavity which manifestly belongs to an avicularium, there is no difficulty in calling the whole structure an avicularium. The proper nomenclature is less obvious when the kenozooecium carries two or several avicularia. For descriptive purposes at least, the only practical method seems to be to term the area a kenozooecium whether an avicularium is present on it or not; — and it may well be the case that this is the correct view to take of its morphology.

It is obvious that a proper appreciation of the changes which occur during growth is of great importance in taxonomic work. Fragments from different regions of the same colony might be regarded as different species if these changes were not taken into account; — and it is not possible to make a complete microscopic examination of every colony. The old condition is in fact very different, in characters apparently of taxonomic value, from the young growing margin.

E. Orifice and Peristome.

The account given above (p. 515) shows that in *Iodictyum* at least the distal wall of the peristome is not a prolongation of that of the zooecium, since there is a distinct interval between its base and the distal septal ridge (Pl. XXXVI, fig. 16). A median labial sinus (text-fig. 25 A, *l. sin*) may occur on the proximal side of its orifice; but more frequently there is a labial pore (C, E, *l. p*), either on the edge of the orifice or at some distance from it; — in the latter event being connected with the edge by a "labial suture" (C, *l. sut*) or by a "labial groove" (E, *l. g*). In zooecia at the growing margin it can often be seen to commence as an open sinus and to

become closed by the apposition of two "sinus-lobes" (B, *s. l*), frequently triangular and meeting by their tips, the closure being sometimes effected mainly by the growth of one of them. The sinuate condition is presumably the more primitive one, but in typically sinuate species (as in *Triphyllozoon hirsutum*) the earliest, centrally placed zooecia may have a closed labial pore (see p. 510); and the sinus of the more peripheral zooecia is due to the failure of the sinus-lobes to unite. It thus appears probable that the Reteporidae have evolved from ancestors with a closed pore and that the sinus, when it occurs, is a reversion. Most species have a labial pore and the character is generally very constant, sinuate peristomes being rare. In the sinuate species, variations are more common, and in some of them a typical labial pore occurs in many zooecia.

The nature of the labial pore has been much disputed. It has been regarded either as a perforation leading into the peristome or as a pore communicating with some cavity inside the zooecium. These apparently conflicting opinions may be reconciled by the suggestion, improbable at first sight, that both are right. There is no doubt that, in *T. hirsutum* for instance (text-fig. 25, B), the labial pore present in some of the zooecia is a "spiramen" (*S*) in JULLIEN's sense; *i. e.*, one which opens into the cavity of the peristome. The proximal margin of the primary orifice of Retepores is frequently (if not always) provided with a proximal transverse tooth or "lyrula" (F, I, *l*), continuous with the margin on one side, passing across the orifice somewhat obliquely and ending abruptly on the other side, in such a way as to form a minute unilateral sinus (see also text-fig. 40, p. 615). In certain species, as in *Reteporellina denticulata*, the primary sinus is continued on the inner side of the proximal wall of the peristome by a "sinus-groove" (text-fig. 25, D, *s. g*) leading to the external sinus of the secondary orifice, and indicated on the outer side of the peristome by a longitudinal fold. This relation is also well shown in *Iodictyum willeyi* (Pl. XXXVI, fig. 22), in which the sinus-denticles visible in the peristomial orifice are the frontal ends of the "sinus-ridges" by which

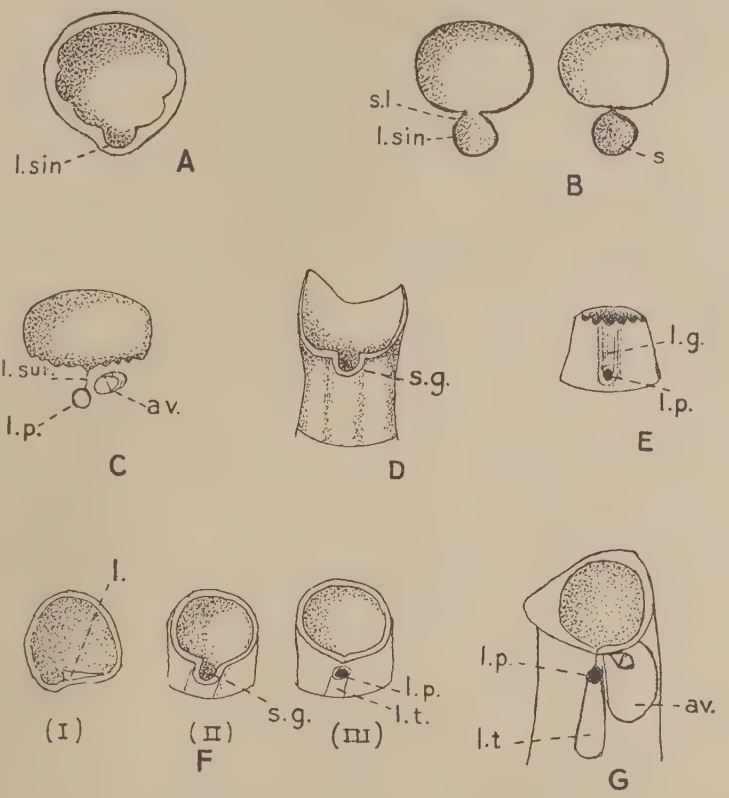

Fig. 25. — Forms of peristome, illustrating the morphology of the labial sinus and pore. — A, *Iodictyum sanguineum*, Brit. Mus., 92. 1. 28. 109; B, *Triphyllozoon hirsutum*, 193. C^1, closure of sinus by the union of the two sinus-lobes to form a spiramen; C, *T. bimunitum*, 184. A^2; D, *Reteporellina denticulata*, 165. C; an external longitudinal projection corresponds with the internal sinus-groove; E, *Reteporella graeffei*, 221. A, labial pore distant from the edge of the peristome, at the end of an external labial groove; F, *Triphyllozoon inaïvisum*, 346. A^3, three stages in development (I) primary orifice with a proximal denticle (lyrula) and an asymmetrical sinus; (II) prolongation of the sinus as a sinus-groove; (III) groove closed to form a labial pore and a short labial tube; G, *T. separatum*, 111. F^1, labial tube long, visible through the semitransparent wall of the peristome. — *av*, labial avicularium; *l*, lyrula; *l. g*, labial groove, on outer wall of peristome; *l. p*, labial pore; *l. sin*, labial sinus; *l. sut*, labial suture; *l. t*, labial tube; *s*, spiramen; *s. g*, sinus-groove, on inner wall of peristome; *s. l*, sinus-lobe.

the sinus-groove is defined. In other species, as in *Triphyllozoon indivisum* (text-fig. 25, F, II, III) the two sinus-ridges which at first limit the groove coalesce by their edges. There is now an obliquely vertical "labial tube" (25, F, III and G, *l. t*), passing from the primary sinus to the labial pore, its external opening. The same changes are shown, not diagrammatically, in text-fig. 40, p. 615 and Pl. XL, fig. 12. The labial tube is of considerable length in some species with a long peristome; and in young zooecia with semitransparent walls of *T. separatum* (text-fig. 25, G, *l. t*) it may be distinctly seen to end basally in the region of the proximal border of the operculum. The same relations can be equally well seen in *T. bimunitum* (text-fig. 41, B, p. 617).

The labial tube is accordingly a special form of ascopore, leading to the compensation-sac, the existence of which in Reteporidae may be assumed. The "tube" noticed by WATERS (1895, MNZR, p. 256; 1913, BEA, p. 524) seems to be the labial groove, and in another memoir (1904, BB, Pl. VI, fig. 6*a*) I think he incorrectly represented a labial tube opening into the zooecial cavity at a point far removed from the base of the operculum.

The sinus-groove and the labial tube are no doubt arrangements correlated with a tubular peristome which is from time to time occupied and partially blocked by the expanded tentacles. Without some such a device, the compensation-sac could not efficiently discharge the water which must pass out of it when the tentacles are being retracted.

Marginal teeth and denticles (see p. 508) are specially characteristic of *Iodictyum*. The denticles, which project into the peristome, are remarkably constant in their number in certain species of this genus. Thus in *I. axillare* (p. 553), *I. deliciosum* (p. 554) and *I. polycrenulatum* (p. 558) their number is almost constantly 10, in addition to the two sinus-denticles. It is probable that this regularity in number is more than a coincidence; and, although I have no direct evidence on the subject, I suspect that it will be found to be correlated with the number of tentacles. On this hypothesis, each of these may be supposed to lie, during the protrusion of the polypide, in one of the grooves between the denticles and their continuations as ridges down the peristome. The number of tentacles in Reteporidae seems to be always small; and, as recorded by WATERS (1904, BB, pp. 80—85; 1909, SRS, pp. 176, 177; and 1913, BEA, pp. 526, 527) it ranges from 11 to 15. *Iodictyum* is unfortunately not represented in these records.

It has been pointed out above (p. 510) that the zooecia in the neighbourhood of the ancestrula may have conspicuous spines; 3 : 3 in the case of *Triphyllozoon hirsutum*. This species is remarkable for the very numerous spines present, in certain colonies, on practically all the active zooecia. In other colonies which appear to be referable to this species, the spines are much less profusely developed. In most species, actual spines have to be looked for at the growing margin or even on colonies in their initial stages of growth. In many instances a single pair of spine-bases may be found on the zooecia, both young and old. It is uncertain whether these are always the remains of actual spines, and perhaps in some species spine-bases are vestiges, not implying that actual spines have been present.

Certain Reteporidae have obviously dimorphic peristomes, some completely tubular (text-fig. 34, B, p. 586) and others with a deficient distal wall (Pl. XXXVIII, fig. 21, left distal zooecium), the lateral walls often ending abruptly, their distal edges reaching the frontal surface. I have not found any discussion of the meaning of this dimorphism, which I believe to be correlated with the existence of two kinds of zooecia; — those that are at least potentially oviparous and

those in which no eggs are produced. My evidence is entirely derived from the development of the ovicells.

The basal wall of the ovicell is the first to develop (see p. 523 and text-fig. 26, p. 522); and in Reteporidae in general, as in other Cheilostomes, the young ovicell is a concave, two-layered structure which lies horizontally at the distal end of a zooecium. The mature ovicell is connected with and opens into the peristome, which must be incomplete distally if the ovicell is to have room for development in its proper relation to that structure. If even a short basal part of the peristome were completely tubular, the normal growth of the ovicell would be prevented. This dimorphism is a conspicuous feature in *Iodictyum*. In a growing marginal lobe with ovicells in various stages of development, these structures invariably occur at the distal ends of the zooecia with incompletely tubular peristomes. The converse statement is not true, since many incomplete peristomes occur without associated ovicells. It may be supposed, however, that a colony cannot support a number of ovicells in excess of the amount of nutriment which can be supplied to the developing eggs and embryos. This suggestion follows from the fact that many ovicells which commence to grow remain, at various stages, in an incomplete state. The ovicells are produced, with the zooecia and the primary avicularia, at or near the growing margin, and I doubt whether any can develop on an old part of the colony. If an unfinished ovicell is at a distance from the edge greater than that of the completed ovicells, it probably means that it has missed its chance and will never develop further. It is a fair deduction that this failure to grow implies an insufficient amount of nutrient material; and it is a fact that the number of perfect ovicells is frequently much lower than that of zooecia which commence to produce these structures. I therefore think it probable that a colony provides a larger number of incompletely tubular peristomes than will actually be required; and, although I have no direct evidence on the subject, that the corresponding zooecia are potentially fertile. It may well be the case that all zooecia of this kind are either capable of developing an ovary or actually produce it, even if ripe eggs are not formed. For descriptive purposes it is convenient to have names by which to distinguish the two kinds of peristome. I term the completely tubular ones "ordinary" and those with a distal deficiency "fertile", the latter name not implying that an ovicell necessarily develops in connexion with a peristome of this kind.

In certain other genera of Reteporidae, and particularly in *Triphyllozoon*, a dimorphism of the peristomes is not apparent, since the distal wall is little developed in any of the zooecia. The ovicell in these cases also is always found in connexion with a peristome deficient distally; but as all the peristomes are practically in this condition, I have not been able to distinguish between ordinary and fertile peristomes.

A considerable amount of variation in the proportions of the opercula is noticeable in many Retepores. In *Iodictyum*, for instance (see p. 546 and Plates XXXVI, XXXVII) the proximal margin may be straight or curved, and the ratio of width to length is not constant. Although these differences are conspicuous when extreme cases are compared, I have not succeeded in dividing the opercula into two distinct groups, nor in correlating the differences with the dimorphism of the peristomes. The possibility that a correlation exists is not excluded, and the occurrence of special opercula in the fertile zooecia is of course well known in some other Ascophora.

F. Ovicell (see also p. 521).

The characters of the ovicell are specially important for the definition of genera in Reteporidae, as was recognized by Canu and Bassler, who introduced several generic names which deserve acceptance. The distinguishing features of the genera here considered will be found in the Systematic part of the Report, where I make use of the following terms.

The frontal wall of the globose, thin-walled ovicell slopes down into the peristome, and this part is the "descending lamina". If its descent is steep, as is often the case, it is difficult

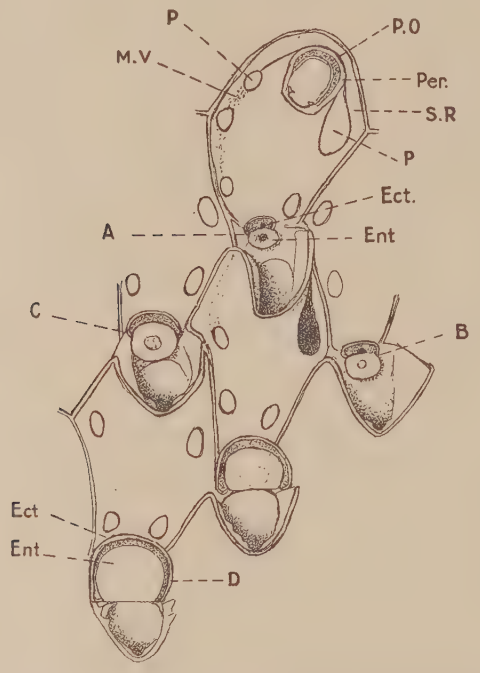

Fig. 26. — *Iodictyum sanguineum*, Brit. Mus., Torres Straits 90.3.24. 89; illustrating the early development of the ovicell. In the uppermost zooecium the edge of the primary orifice is visible, the peristome being in its initial stage and completely separated from the distal septal ridge of the zooecium. *A*, ovicell in its initial stage (see text), *B*, *C*, later stages; *D*, an ovicell which has reached its full width, the entooecium being deeply concave, its frontal portion not yet developed; *Ect*, ectooecium; *Ent*, entooecium; *M.V.*, marginal valley, with pores (*P*); *Per*, peristome; *P.O*, edge of primary orifice; *S.R*, septal ridge.

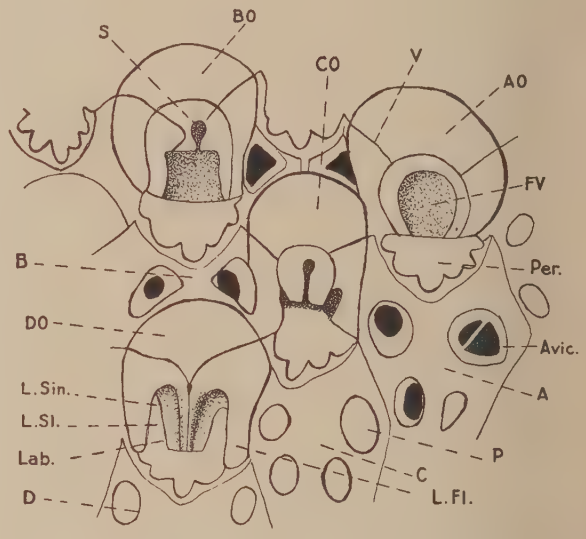

Fig. 27. — *Iodictyum sanguineum*, same slide as Fig. 26. Later growth of the ovicell. *A—D*, zooecia; *AO—DO*, the corresponding ovicells, *AO* slightly later than Fig. 26, *D*; *BO*, later stage, the frontal vacuity reduced, an open sinus remaining distally; *CO*, frontal vacuity reduced to a median slit; *DO*, mature ovicell with carinate labellum. The outlines of the primary ovicells are indicated but are actually obscured by overgrowths from the adjacent zooecia. *Avic*, avicularium; *F.V*, frontal vacuity of immature ovicell; *Lab*, labellum; *L.Fl*, lateral flange; *L.Sin*, lateral sinus; *L.Sl*, lateral slit; *P*, pore; *Per*, orifice of peristome; *S*, sinus of young ovicell; *V*, vibex. (Pl. XXXVII, fig. 15 is another representation of this specimen.)

to observe the form of its free proximal edge. In certain Reteporidae this is produced into a free median lip, the "labellum" (Fig. 27, *Lab*), which, in *Iodictyum*, bears a longitudinal carina, bordered on each side by a "lateral sinus" (*L. Sin*), in the deep wall of which is an open slit, the "lateral slit" (*L.Sl.*). The "lateral flanges" (*L.Fl*), forming the outer boundaries of the lateral sinuses, are proximal continuations of the frontal wall of the ovicell into the lateral parts of the peristome.

The ovicells commence their development in substantially the same way in all Reteporidae, the genera of which differ in the manner in which it is completed. Buchner (1924, UJR, text-figs on pp. 165—169), for instance, figured the changes that occur in several genera; and Okada (1920, RAJ, text-fig. 3, p. 622) described them in *Iodictyum axillare*. Some of the

conditions he observed are doubtless parts of a developmental series, but they were not placed in a sequence suggestive of this fact. In two or three instances his ovicells were probably seen obliquely, so that the apparent asymmetry is due partly to the fact that one side is not completely visible. Immature ovicells have been figured by various authors, and in some cases they have been described as if they had reached their final adult form. LEVINSEN (1909, MSSB, p. 290) stated that the ovicells "spring from a narrow, sometimes almost stalk-like[1]) proximal part", and they "seem originally always to be free and able to be isolated, even though they later "get firmly imbedded in the colony by covering layers" (p. 63). WATERS (1913, BEA, p. 525, Pl. LXXII, figs 1—7) figured and shortly described their development in *Triphyllozoon cuspidatum* (as *R. monilifera*, var. *umbonata*), his account agreeing in the main with LEVINSEN's statement.

The ovicell of *Iodictyum* passes during its development through stages which correspond with the mature ovicells of other genera of Reteporidae, though it is not unique in this respect. At its earliest appearance it consists of two parts; (*a*) a horizontal gently concave disc (text-fig. 26, *A*, *Ent*), situated in the region of the deficient distal wall of the peristome. The disc has a free circular edge, and corresponds in part with the stalked structure described by LEVINSEN. A dark spot in the middle is probably the lumen of the stalk seen through the wall of the disc, which is the future entooecium; (*b*) a crescentic horizontal and concave plate, the future ectooecium (*Ect*), which at present lies mainly on the distal side of the disc. A minute median pore occurring in the crescent of the ectooecium opens into the space between the two layers of the ovicell and probably persists in the mature structure. Both parts next expand horizontally in a lateral and distal direction (*B*, *C*). The entooecium continues to be concave frontally, and its free edge becomes concentric with that of the ectooecium. When they have reached their full length and width (*D*) the basal and the greater part of the lateral walls are complete. Both layers grow frontally and towards the middle line (text-fig. 27, *AO*), the ovicell now showing its future spheroidal shape, with a wide vacuity (*FV*) in the frontal wall. So long as the growth of the two layers is vertical their edges are easily visible. These are the limits of the parts calcified at the moment, but the young ovicell is probably a curved fold in which the calcified edges are connected by a living membrane. *BO* is a later stage, in which the frontal vacuity has closed further, a small sinus occurring in it distally, and the ectooecium now overlies the distal and lateral parts of the entooecium. The ovicells *AO* and *BO* are approximately in the condition which is permanent in *Hippellozoon*, as shown by WATERS (1895, MNZR, Pl. VII, fig. 3) in *H. novae zelandiae*; and in *Schizoretepora*, as illustrated by BUSK (1884, Chall., Pl. XXVI, fig. 9, *b*, *c*) in *S. imperati*. In *CO* the frontal vacuity has become a narrow slit, the sinus of *BO* being still recognizable at its distal end. The calcareous plate including the slit is the labellum, which is complete in *DO* (*Lab*). As the slit closed, its two limiting edges became raised, so that their line of fusion formed the summit of the longitudinal carina which extends down the labellum to its free proximal margin; the distal end of the suture nearly always showing a minute pore, the remains of the original sinus.

A further point is illustrated by text-fig. 27. The mature ovicell is commonly crossed by a pair of obliquely transverse vibices (*V*), whose position indicates that the primary ovicell

1) The stalk may remain visible in mature ovicells, as shown by Miss HASTINGS (1932, PGBR) in her text-fig. 16 on p. 441, although not in such a way as to suggest that it is connected with the basal wall of the ovicell.

has become overlaid by prolongations of adjacent zooecia; and these are the "covering layers" of LEVINSEN referred to above (p. 523). It is obvious that these lines divide parts of zooecia which have extended frontally over the ovicell, since the terminal or distal wall of the fertile zooecium lies on the basal side of the ovicell and near its proximal end. The zooecium *C* extends laterally over the ovicell *DO*, as far as the vibex which crosses it. There is no such extension on the right side of *C* because there is here no ovicell. The zooecium *B* similarly extends laterally over the two ovicells on either side of it (only the right one fully shown) and proximally over the ovicell *DO*. The primary ovicell thus becomes covered by calcareous layers derived from three adjacent zooecia, two of which are lateral and one is distal. BUCHNER (1924, p. 164) mentioned the contributions of the lateral neighbours, but he stated that these and the ovicell-bearing zooecium contribute calcareous covering layers. My figure shows that the median zooecium which overgrows the ovicell is the distal successor of the fertile zooecium, not the fertile zooecium itself; and this can be seen to be the case in BUCHNER's figure on p. 166. It may be added that the avicularia so commonly found on the ovicells of Reteporidae are produced by the secondary extensions of parts of the zooecia over the ovicells.

A very young ovicell of *Triphyllozoon bimunitum* (Pl. XLI, fig. 6, *Ov*) differs materially from those of *Iodictyum* and agrees more nearly with the accounts given by LEVINSEN and WATERS. It appears to have originated from a pore in the terminal wall of the zooecium, giving rise to a tube slightly widening for a short distance and then suddenly expanding in a fan-like manner. The distal expansion consists of the concave, exposed entooecium, and of the ectooecium on its basal side, one edge of it being seen to the left of the figure. The two layers are nearly in contact with one another, but the very shallow cavity between them doubtless communicates with that of the tubular stalk.

The morphological nature of the Reteporidan ovicell is not clear, and I am not sure that this structure agrees with any of the types shown in fig. 1 on p. 202 of this Report (Part II). The entooecium was there supposed to belong to the proximal frontal wall of the distal successor of the fertile zooecium, the ectooecium being also developed by the same individual. The very young condition described in the preceding paragraph seems to show that the ovicell is developed from a single 'Anlage'; but in *Iodictyum* both layers originate well within the distal septal ridge, which is presumable the free end of the terminal wall of the fertile zooecium. The evidence seems to be in favour of the view that the Reteporidan ovicell is developed from the fertile zooecium.

The fact that the Reteporidan ovicell is invariably developed on a zooecium in which the distal wall of the peristome is wanting (see p. 521) is significant, and it suggests the possibility that it might represent the deficient distal wall, deflected into a horizontal position. My evidence is insufficient to permit me to express a definite opinion on this point, or to justify a further discussion of the problem, which needs further investigation. The Reteporidae cannot be considered by themselves, since their ovicells are closely similar, in general features at least, to those of many other Cheilostomes. In this connexion it is worth while to notice the statement of Canu (1907, Ann. Paléont., II, p. 154) that the peristome is an ancestral character present in almost all the Escharine Cretaceous Polyzoa. Definitely peristomial ovicells occur, moreover, in certain recent Cheilostomata.

G. Avicularia.

Avicularia are of special taxonomic importance in Reteporidae. While the genera are distinguished mainly by the characters of the ovicells, the species can most readily be recognized by the avicularia (including the mandibles); the large fenestral avicularia of the frontal surface, when they occur, being particularly useful for this purpose. The term "avicularium" is commonly used to indicate the part of it visible in a superficial view; and the larger portion, containing the muscles and often immersed in the zoarium, has been described as the "avicularian chamber". "Avicularium" should obviously signify the entire structure, but no confusion need arise if the term is sometimes employed in the more restricted sense of its visible portion. It should be understood, however, that a comparatively small rostrum and mandible often correspond with a large immersed cavity containing the muscles, and particularly the occlusors, which are often very strong. When any kind of fenestral avicularium is mentioned in the following pages, it may be assumed, unless it is stated to belong to the basal surface, that it is a derivative of the opposite surface. These avicularia are in most species the frontal avicularia of marginal zooecia, more or less modified in position, form and size. In *Iodictyum*, however, I have clear evidence that, in several species, the infrafenestral avicularia (Pl. XXXVII, figs 1, 9, 20) are vicarious; developing at the growing margin as areas surrounded by septal ridges (Pl. XXXVI, fig. 16, *V. Av*) like those of the zooecia. Both conditions are found in *I. perarmatum*, where the lateral fenestral avicularia are modified frontal avicularia (text-fig. 29, p. 562), but the infrafenestral avicularia, in this species as in others of the genus, are vicarious and of specially large size (Pl. XXXVII, fig. 20). Many species of *Triphyllozoon* have a conspicuous infrafenestral avicularium, which when present has a nearly constant position, on one side of the fenestra (less often on both) directed proximally and so situated that the distal end of its rostrum nearly reaches the middle line of the fenestra (Pl. XXXIX, fig. 20). The lateral fenestral avicularia, when these occur, are also directed proximally in most cases. A suprafenestral avicularium is generally the enlarged frontal avicularium of a zooecium on the distal side of the fenestra; and these avicularia are often specially large and strong. The labial avicularia, nearly always unilateral, typically have a very small rostrum and mandible, but their cavity containing the muscles may be large enough to form a conspicuous inflation of one wall of the peristome (text-fig. 47, *l. av*, p. 629, Pl. XXXVIII, fig. 15).

The secondary avicularia produced by frontal kenozooecia commonly have a different orientation from those of the primary set, developed at the growing margin. This is well shown in *Iodictyum phoeniceum*, in which the primary avicularia are directed obliquely distally (Pl. XXXVI, fig. 7); the secondary avicularia having no constant orientation. In many species, small avicularia are found on or among the ovicells; and these are secondary, since they cannot be developed until the primary ovicell has been covered by overgrowths of the adjacent zooecia (see p. 524).

The occurrence of avicularia of all kinds seems to be extraordinarily capricious, within the limits of a single species or of an individual colony. One specimen may have them in profusion, while in another a careful search may be required to find a single avicularium. Avicularia of a particular type may be common in one colony, rare or wanting in another belonging to the same species. This inconstancy of occurrence adds greatly to the difficulty of defining species

and of recognizing their aberrant members. In a preliminary paper (1909, BA, pp. 733—730) I discussed the forms and the distribution of avicularia and I ventured to suggest that some of the perplexing facts might possibly be explainable on the assumption of a blastogenic segregation of characters comparable with the gametic segregation recognized by workers in genetics. My suggestion was a mere guess, based solely on the observed occurrence of the avicularia. I do not attach undue importance to it, and I mention it partly in order to explain that the specimens I there (p. 728) referred to as varieties of *Retepora phoenicea* are distributed in the present Report among the species of *Iodictyum*. The attempt of CANU and BASSLER (1929, BPR, p. 360) to correlate the distribution of the avicularia with "the immediate biologic needs" of the colony appears to me unconvincing.

The smaller avicularia of Reteporidae are of two kinds, which may be referred to, respectively, as "round" and "oval". Both kinds may be found frontally or basally, often most frequently in the margins of the fenestrae. They are specially common in species of *Triphyllozoon*, but are rare in *Iodictyum*. The round ones have rostra and mandibles which are typically almost semicircular, their curved free margin being often finely denticulate. They are generally slightly wider than long, sometimes much wider, but the length may be greater than the width. In one or two species the labial avicularia, which belong to the round type, are definitely acute. BUCHNER (1924, UJR, p. 174) has figured continuous series connecting an elongate, triangular mandible with a rounded mandible which is a segment of a circle less than a semicircle. The difference between an acute mandible and a rounded one thus appears not to be fundamental. Even the smallest of the avicularia with rounded mandibles have relatively strong mandibles and occlusor muscles.

Although it is not always easy to distinguish the two kinds of small avicularia by a superficial examination, I believe the oval avicularia (Pl. XXXVII, fig. 19, *c*) to constitute a distinct type; as was maintained by WATERS (1904, BB, p. 77), who termed it the "Reteporidan avicularium". The oval avicularia are very shallow and regularly oval. The mandible is specially thin and delicate, and the occlusor muscles are much smaller than in the round avicularia. In some species their mandibles are as large as the opercula.

As above indicated, BUCHNER appears to regard the large acute avicularia, as well as the smaller ones of the same form, as belonging to the same type as the small round ones; but there are other large avicularia which seem to belong to the same assemblage. The most striking of these are the "munitiform" avicularia which were first described by HINCKS in *Triphyllozoon munitum*, originally introduced as a variety of *Retepora monilifera* (See HARMER, 1933, GR, p. 623). As they are found not merely in other species of *Triphyllozoon*, but also in other genera, it is unnecessary to assume, as has often been done, that species with munitiform avicularia are nearly related. In certain species, as in *T. tuberculiferum* (p. 626), frontal avicularia can be found transitional between the ordinary small round avicularia and the fully developed munitiform type (Pl. XLI, fig. 17; text-fig. 42, A, p. 621, *M. av*). In this extreme form the mandible is exceptionally thick and strong, of a deep brown colour, and its occlusors are very powerful. Such avicularia are often suprafenestral (Pl. XL, fig. 1), but they may occur on the general frontal surface and, rarely, on the basal surface. I regard them as a modification produced as the result of an increase in size of all parts, specially of the rostrum, the mandible

and the occlusor muscles. This modification appears to have taken place independently in several lines of evolution in the Reteporidae.

On pp. 602, 604 I have suggested that the large raised "frontal" avicularia found in *T. tubulatum* (Pl. XXXIX, fig. 15) and in *T. patens* (as well as in *T. columniferum*) are another modification of the small round type, and that they are labial avicularia. In these species the rostrum and mandible are longer than wide, and the minute denticles often found on the mandibles of ordinary round avicularia have become long, conspicuous teeth (Pl. XXXIX, fig. 12).

The acute frontal avicularia vary much in size. Some are regularly triangular, the rostra with or without cusps (Pl. XXXIX, fig. 24); relatively wide and short, or narrow and elongate, with intermediate conditions. An acute avicularium occurring suprafenestrally may be exceptionally large (Pl. XL, fig. 14,*b*), often much raised distally and with very powerful occlusors. Large avicularia with simple, acute mandibles may have rostra more or less raised distally into two cusps, often strong, triangular and acute (Pl. XXXIX, fig. 1). In *Triphyllozoon trifoliatum* (Pl. XL, fig. 7) and *T. indivisum* (Pl. XL, fig. 11), in both of which the two cusps are specially strong, the mandibles are trifoliate (Pl. XL, figs 9, 10). the median branch closing between the two cusps of the rostrum, the lateral branches on the proximal sides of the cusps. *T. bimunitum* (Pl. XLI, fig. 1) has conspicuous avicularia of the same type and the mandible (Pl. XLI, fig. 3) may be widened distally, at a level corresponding with the origins of the lateral leaves of the trifoliate mandibles. In certain infrafenestral avicularia, as in *T. tubulatum* (Pl. XXXIX, fig. 15) the rostrum, which more or less faces the fenestra, is much widened distally, where it is bifid, each of its two lobes having 1 or 2 cusps and receiving one of the branches of a bifoliate mandible (Pl. XXXIX, fig. 10). The rostrum is thus tricuspid or quadricuspid. In *T. philippinense* (Pl. XXXIX, fig. 5) the frontal cusp may be reduced or suppressed, so that the rostrum appears curved laterally and the mandible (Pl. XXXIX, fig. 8) shows an asymmetry which suggests that it is a modification of a bifoliate type, with one of the two leaves wanting. In *T. patulum* (Pl. XLI, fig. 20) the rostra and mandibles of the large avicularia are all rounded or spatulate, the rostra without even vestiges of cusps. It is possible that these are a large form of the small oval avicularia: but on the other hand the large acute mandibles of *T. benemunitum* (Pl. XXXIX, fig. 26,*b*) resemble the rounded mandibles of *T. inornatum* (Pl. XL, fig. 3,*c*); and it can hardly be doubted that the avicularia in question belong to the same type.

In certain species the general basal surface has no avicularia, although the small round and oval kinds may occur, basally, in the margins of the fenestrae, into which each such avicularium may project as a prominent cone. In many of these cases the projecting part is not the rostrum (as might have been expected) but is the raised proximal end. In other species, but sometimes in particular parts of colonies in which basal avicularia are otherwise rare, these small avicularia may be found in exceptionally large numbers, on the general surface or in the fenestrae, or in both positions. A similar abundance of small avicularia may occur on the frontal surface; but I have not found that, as stated by BUCHNER (1924, p. 169) this is generally the case in colonies with numerous basal avicularia. It seems probable that an excessive number of small avicularia results from their secondary development on kenozooecia.

In general, as BUCHNER has stated (p. 169), there is some correlation between the large avicularia of the two surfaces. Thus bifoliate forms occur basally, as well as frontally (where

they are infrafenestral), in *Triphyllozoon tubulatum*; and *T. bimunitum* has enormous basal avicularia (Pl. XLI, fig. 2) which resemble those of the frontal surface. The large basal avicularia, which seem to be always larger than the corresponding avicularia of the frontal surface (cf. Pl. XXXIX, figs 10, 11), generally have a horizontal rostrum and are much inflated; — a condition which disappears later by immersion due to secondary calcification. I have found no large basal avicularia in certain species, such as *T. philippinense*; but they are fairly common (though not always present) in the allied species *T. hirsutum* (text-fig. 36, p. 597), as well as in *T. mucronatum* (text-fig. 42, B, p. 621) and in species of *Triphyllozoon* with bifoliate mandibles.

In the oldest parts of the colonies, avicularia are wanting on both surfaces, owing to their immersion and occlusion. This was noticed by Levinsen (1909, MSSB, p. 293); and the process has also been described by Buchner (1924). On p. 178 Buchner figures a section of the basal plate of a Retepore, composed of layers of avicularia which have been successively superposed on their predecessors; mandibles of the buried avicularia being visible in various parts of the section. A similar process of occlusion can often be seen on either surface of a branch, where all stages of the disappearance of the avicularia may be found. A partially buried avicularium may look like a pore and is sometimes not easily distinguishable from an ordinary surface-pore (see p. 517 under kenozooecia).

H. Commensals of Reteporidae.

Canu and Bassler (1929, BPR, p. 361) have made the following assertion referring to "the reteporidan mystery"; — "Never is a complete living colony encrusted by another organism. "No larva has been able to develop here and disturb the harmony, no spores of the nullipores "have been able to propagate themselves". This generalization was repeated by them in 1930 (BT, p. 62); but it goes too far.

In 1909 (BA, pp. 720, 721), while suggesting that, thanks to their avicularia (which probably prevent the fixation of larvae), Retepores were usually free from encrusting organisms on their active parts, I pointed out that two organisms "of suitable habit" had "succeeded in "establishing themselves in the very midst of the defensive works" of the Retepores of the Siboga Collection. One of these is the Entoproct *Loxosoma* and the other was referred to as a Gymnoblastic Hydroid of *Syncoryne*-like appearance.

(1) *Loxosoma*.

Organisms recognizable as *Loxosoma*, although shrivelled and distorted, may be found in plenty on dry Museum colonies of Reteporidae; as, for instance, on some of Busk's 'Challenger' specimens in the British Museum. Many of the well preserved Retepores of the Siboga Collection are heavily infested with *Loxosoma*, of which I described 5 species in this association, in Part I (1915, pp. 11—17) of this Report. Buchner (1924, UJR, p. 187) subsequently introduced a new species, *Loxosoma reteporae*, which he found on Japanese specimens of *Schizoretepora tumescens* (*Retepora tumescens*). He gave no indication of its characters and made no reference to the species I had described. I subjoin a list of my species, with their respective hosts, which I was unable to determine in 1915.

REPORT, I PAGE	SPECIES OF LOXOSOMA	SPECIES OF HOST		STATION	DEPTH IN METRES
11	*L. annulatum*	195. A, *Triphyllozoon*	*benemunitum*	274	57
	"	247. A, "	"	310	73
	"	133. B, "	*tubulatum*	164	32
	"	24. A, "	*inornatum*	53	0—36
13	*L. velatum*	24. A, "	*inornatum*	"	"
14	*L. cirriferum*	193. A, "	*benemunitum*	274	57
	"	297. A, "	"	273	13
	"	337. C, "	*tubulatum*	71	0—32
	"	193. F, "	"	274	57
16	*L. circulare*	24. A, "	*inornatum*	53	0—36
	"	281. D, "	*trifoliatum*	43	0—36
	" ?	358. A, *Reteporellina*	*denticulata*	240	0—45
16	*L. pusillum*	133. B, *Triphyllozoon*	*tubulatum*	164	32
	"	193. C, "	*hirsutum*	274	57
	"	108. B, "	*bimunitum*	144	0—45
17	" sp. ?	216. A, "	*inornatum*	285	34
	"	231. A, "	"	305	113
	"	410. B, "	"	"	"
	"	89. A, "	*hirsutum*	116	72
	"	150. A,	"	204	75—94
	"	108. B, "	*bimunitum*	144	0—45
	"	Mus. Cambr., Singapore, HANITSCH, B "	*tubulatum*		6 fath.

Other, undetermined, specimens of *Loxosoma* have been found, since 1915, on Retepores. The occurrences of those determined indicate that each species of *Loxosoma* is not necessarily associated with a single species of Retepore. *L. circulare*, doubtfully determined, was found on *Reteporellina denticulata*; and a single *Loxosoma* (not determined) on *Reteporella graeffei* (137.A). *Loxosoma* sp. incert. is very abundant on the Lifu specimens of *Iodictyum willeyi*; but with these exceptions all my records are from *Triphyllozoon*; and when found they have often been very numerous.

Stat. 53 produced three species of *Loxosoma* on *T. inornatum*; and Stat. 164, two species on *T. tubulatum*. Except *L. velatum* no species was restricted to a single host. *Loxosoma* was found on six of the 13 species of *Triphyllozoon* here recorded, but I have not seen it on *T. indivisum*, *T. patens* and *T. philippinense*; nor, since it is generally a shallow water organism (cf. this Report, Part I, pp. 92—95), on the species restricted to deep water. The greatest depth at which it has been found on Retepores is 113 M.; and most of the infested specimens are from depths of 57 M. or less. The areas most productive of the association are the Southern Islands and the West end of New Guinea, including the Aru Is. I have now one record from Torres Straits and two from Singapore. It may be noted that several of the species on which it was found are specially well provided with avicularia, but the *Loxosoma* is presumably able to place itself where it can avoid injury by these structures. The conditions for its occurrence seem to be much the same as for the Gymnoblastic Hydroid noted below. The numbers of colonies respectively bearing the two organisms are nearly equal; and both occur together on rather more than half of the infested Retepores.

(2) Gymnoblastic Hydroid.

As I have sent specimens of this Hydroid for determination to Professor Billard, I do not wish to anticipate the description he will presumably give in his forthcoming Siboga Report, except so far as the Hydroids affect the structure of their hosts. They will probably prove to be identical with, or allied to, *Zanclea protecta* described by Miss Hastings (1930, AMNH, 10, V, p. 552), who found it on other Cheilostomes, growing in much the same way as those on the Siboga Retepores. In a second memoir (1932, PGBR, p. 450) she recorded the same Hydroid on two species of Retepores.

The Hydroid is found on the frontal surface of its host, in horizontal tunnels which open by circular, even orifices (Pl. XL, figs 1, 2, 13, 15, 17) situated in various parts of the colony. In some instances (fig. 2, H) the tunnel can be seen to originate as a superficial groove, which later closes except for its orifices; and there is reason to believe that its wall is a calcareous secretion of the Retepore, produced in response to the stimulus given by the presence of the Hydroid. I have found no tunnels or grooves on the basal surface, but many of the Hydroid orifices open here in the margins of the fenestrae (text-fig. 28). They are most commonly found infrafenestrally, in the middle line or, less often, two together; but they are not restricted to this position. The tunnel has obviously passed down vertically from the frontal surface along the margin of the fenestra, becoming enclosed by and indistinguishable from that region of the host. The position selected for these orifices appears to be advantageous to the Hydroid by allowing it to expand its hydranth free from interference by the avicularia or tentacles of its host. If a spirit-specimen of a highly infested Retepore is examined it is seen that nearly every fenestra is occupied by one or more hydranths, emerging from the orifices in question, 483.A (*Triphyllozoon mucronatum*) was valuable in proving that the circular orifices seen in dry specimens are connected with the hydrocaulus which ramifies in the Retepore and is visible in stained decalcified fragments. As pointed out by Miss Hastings (1932, p. 450) the Hydroid ramifications were described by Waters (1888, Chall., pp. 2, 21) as parts of a Retepore. Waters later (1910, SRS, p. 254) recognized the occurrence of a Gymnoblastic Hydroid in Cellepores, giving rise to the formation of Hydroid orifices.

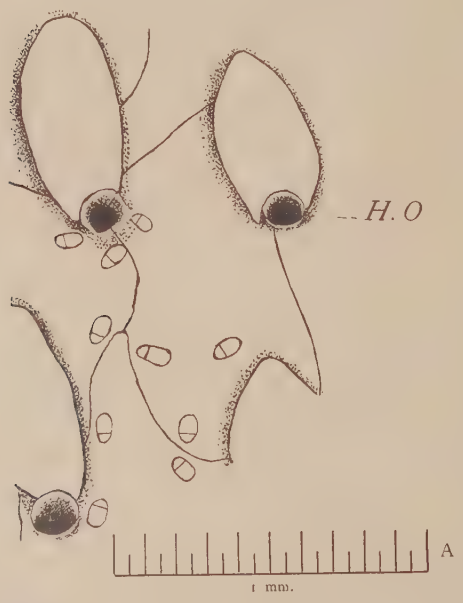

Fig. 28. — *Triphyllozoon benemunitum*, 193. A[1]. Basal surface, showing orifices (*H.O*) of the calcareous tunnels formed by the Retepore round the hydrocaulus of a Gymnoblastic Hydroid.

I believe the Hydroid colony to be completely outside the body-cavities of the zooecia. Since the calcareous tunnels originate as open superficial grooves, they lie in the frontal wall thickened by secondary calcification. Their orifices (text-fig. 28) are of very uniform size; and when their appearance has become familiar by examination of the basal surface of infested Retepores, they can readily be recognized on the frontal surface, as openings smaller than the peristomial orifices (Pl. XL, fig. 1), and with a completely regular circular margin.

In many Retepore colonies a wide, strongly thickened median frontal projection is visible,

generally running longitudinally along the trabeculae and avoiding the orifices. In some instances, but probably not always, this seems to be due to the presence of an immersed Hydroid tunnel.

In view of CANU and BASSLER's statement quoted on p. 528, it should be emphasized that both *Loxosoma* and the Hydroid occur among zooecia in full activity; and in some species of host they are as often present as absent. The association is quite different from the presence of the hydrorhiza of a Hydroid overrunning (as is often the case) the dead or inactive parts of a Retepore.

(3) *Hippothoa distans.*

This delicately constructed Cheilostome, which was described by MACGILLIVRAY in 1869 (PRSV, IX, p. 130), is remarkable for the prolongation of the proximal ends of its zooecia into long, thread-like calcareous tubes which, like the rest of the zooecia, adhere to some substratum. The zooecia are uniserial and widely separated from one another; and in *T. mucronatum* (90. A and 483. A) I have found *H. distans* in large numbers on both surfaces of the Retepore. On the frontal surface the minute zooecia with their delicate prolongations have been able to find room for their growth without interference by the living parts of the colony among which they occur.

(4) Sponges and other organisms.

The basal parts in particular of a Retepore commonly become covered by encrusting Sponges or Compound Ascidians growing on the same substratum. In the case of the Sponges at least the encrustation may advance from the inactive region which it first covered to the living parts of the colony. In some Canada balsam preparations, the remains of polypides are visible under the Sponge, the zooecia outside its growing edge being still active. Serpulids and other small organisms may also occur on living Retepores.

The dead and inactive parts of a Retepore colony form a good substratum for the attachment of organisms of many kinds. With such exceptions as I have indicated, the living parts are generally free from encrusting organisms; a fact which I attribute to the efficiency of their avicularia in preventing the fixation of the larvae of encrusting and other organisms. The first part of CANU and BASSLER's generalization (see p. 528) is no doubt correct if it means that a living Retepore is never completely encrusted by another organism; but not correct if it means that no living part is ever encrusted. The statement that no larva can develop on the living part of a colony is only partially true. *Loxosoma* and the Gymnoblastic Hydroid, as commensals of Retepores, are characteristic of the living, not of the dead portions of their hosts. It seems reasonable to suppose that the original infestation, in these cases, was by means of larvae.

I. DISTRIBUTION.

A. Bathymetrical.

As indicated by the Siboga results, in accordance with previous knowledge, the Reteporidae occur mainly in shallow water and are seldom, if ever, found in the greatest depths. In the present collection the deepest record is 984 M. (*Triphyllozoon patulum*, Stat. 267), and the next in depth are from 500 to 600 M. Of 52 deep Stations (200 M. or more) at which Polyzoa

were found, only 14, or about 27 p. c., produced Retepores. The most remarkable of these is Stat. 156, 469 M., W. of Waigeu Id, where 8 species of Retepores were obtained, of which 6 are here described as new. 5 of the species, belonging to *Iodictyum*, *Sertella*, *Reteporellina* and *Triphyllozoon*, were not found at any other Station. Stat. 105, 275 M., Sulu Archipelago, was almost equally remarkable, producing 8 species of Retepores, 4 of which are new, but one of them, *T. tuberculiferum*, was found also at the adjoining Station 107, of almost the same depth and at Stat. 156, referred to above. Nearly all the new species from these Stations, as well as *Triphyllozoon patulum* from Stations 59 and 267 (390—984 M.), are probably entirely abyssal. 4 species from Stat. 105 are also represented in shallow water; and two of them, *Reteporella graeffei* and *Reteporellina denticulata*, have a wide distribution in the Archipelago and outside it. As indicated under the respective species, one or two of the abyssal records of species commonly found in shallow water were dead specimens which may have drifted from a less deep locality.

I have endeavoured to ascertain, by the examination of the complete records (Polyzoa) for the Stations, whether the Reteporidae show a preference for localities of any particular character. The members of this Family generally require a firm and solid support, with the exception of certain species, such as *Triphyllozoon hirsutum*, which may commence its growth on the flexible stem of a Hydroid and ultimately form a large zoarium traversed by the Hydroid axis. The result of this enquiry is that Retepores in general flourish in situations suitable for other Polyzoa, particularly those of a similar rigid constitution. The nature of the suitability is insufficiently known, but that local conditions are important in this connexion is shown by the remark of Waters (1904 BB, p. 79) that "there is no part of the world where there are so "many massive and solid Bryozoa as South Africa, and where genera generally delicate, are found "with thick calcareous growth". Curiously enough, this region is one from which singularly few Retepores have been recorded.

The deep water Stations at which Retepores were obtained are nearly all described as having a bottom of coral, coral-sand, coarse sand or stones. Cyclostomes of rigid growth occurred in 6 of the 14 Stations which produced Retepores, but there is only a single record of them in the 37 deep water Stations where no Retepores were found. These 37 were mainly unfavourable for Polyzoa, as shown by the fact that 23 of them had only 1—2 species each. Judging by the nature of the bottom, some of these might have included Retepores; but since the ratio of Retepores obtained in deep water to the total number of Polyzoa at the same Stations is 1 : 2·7, the chance of finding Retepores was not great. In a large proportion of these 37 Stations the bottom is described as muddy; and, in accordance with expectation, it may be concluded that this sort of bottom is unsuitable for Polyzoa requiring a rigid support, and therefore for most Retepores. The most striking general character of the Stations in question is the occurrence of a large proportion of delicate deep water Cellularine forms and of Bifaxariidae, *Conescharellina* and *Zeuglopora*, which can attach themselves to small objects by chitinous rootlets. Ctenostomes were not found in any of the deep water Stations; and Entoprocta occurred only twice, at Stations 105 and 156, at both of which Retepores occurred, but in neither instance on the Retepore.

Of the 84 shallow water Stations which produced Polyzoa, Retepores were found in 46, or in about 55 p. c. Mud is mentioned at many of them, but almost always with the addition

of sand or other firmer substance; while at some of the Stations the bottom was composed of Lithothamnion or other substance obviously suitable for the attachment of rigid Polyzoa. In this group of Stations, however, there is no clear difference between those which produced Retepores and the others.

The shallow water localities most productive of Retepores, the numbers of species of which are given in brackets, are Stat. 144, W. of Halmaheira, 0—45 M. (6); Stat. 273, Aru Is., 13 M. (5); Stat. 164, W. of New Guinea, 32 M. (5); Stat. 99, Sulu Archipelago, 16—23 M. (4); Stat. 257, Kei Is., 0—52 M. (4); Stat. 282, E. Timor, 0—54 M. (4); and Stat. 310, Sumbawa, 73 M. (4). In five of these Stations the total number of Polyzoa was specially high (54—135); and Stat. 164, with 135 records, was the most productive of all the Stations. The high proportion of Retepores at Stations 257 and 282, with respective totals of 25 and 27, is noteworthy; but in both instances the bottom included coral. Stations 50 (total 76) and 77 (total 84), on the other hand, had a low production of Retepores, respectively 2 and 1. Mud, sand and shells occurred at Stat. 50; and fine grey coral-sand at Stat. 77.

A striking fact in distribution is the rarity of the records of Polyzoa in two areas of the Archipelago. In the Strait of Makassar a single specimen was obtained in each of 4 deep water Stations (74, 76, 87 and 90), and two specimens at Stat. 88; but there were no Retepores. In all five except Stat. 90 the nature of the bottom, *Globigerina* or mud, was probably unsuitable for these forms. Of the shallow water Stations, 78, 79, 79[a] and 89, with a total of 7 or less each, produced no Retepores, although the bottom, coral or coral-sand, does not appear to have been unfavourable. The remaining five Stations indicate that conditions in the Strait are not very favourable for Retepores, as shown below:

STATION	DEPTH	BOTTOM	TOTALS	
			POLYZOA	RETEPORES
77	59	Fine grey coral-sand	84	1
71	0—32	Mud, sand with mud, coral	41	1
81	0—34	Coral and Lithothamnion	34	2
80	40—50	Fine coral-sand	33	2
91	0—54	Hard coral-sand, coral, Lithothamnion	14	1

Stat. 81 produced *Iodictyum projectum* and *I. polycrenulatum*; by a curious coincidence represented solely by minute colonies composed of a very small number of zooecia (pp. 507, 510). Neither species is specially common in the Archipelago. The species obtained at the other Stations were *Triphyllozoon tubulatum*, *T. hirsutum* and *Reteporella graeffei*, all frequently recorded elsewhere. At all five Stations other Cheilostomes formed at least 65 p.c. of the total.

The records for the Banda Sea are even more striking. Polyzoa were obtained in small numbers at 6 deep water Stations (208, 221, 226, 227, 241, 280), in 3 of which mud occurred at the bottom. No Retepores were found, but the least depth of these 6 Stations was 1224 M., which is beyond that at which Retepores ordinarily occur. In all these Stations Polyzoa were represented by Bifaxariidae and Cellularines of the abyssal type. Of 10 shallow water Stations, Polyzoa were few, with no Retepores, at 180, 181, 184, 209, 220, 225, 227 and 279. At Stat. 240 *Reteporellina denticulata* was found as 1 out of about 47 records of Polyzoa; and at Stat. 204

Triphyllozoon hirsutum was 1 out of 14. Both are common species and no other Retepores occurred at any of the Stations immediately surrounding the Banda Sea, although they were fairly well represented at the Kei Is (Stations 250, 257, 260) to the East, and off the E. point of Timor (Stations 282, 285) to the South.

I am greatly indebted to Professor WEBER for having called my attention to the important results of BÖGGILD, 1916, published in Livr. LXXIX ("Meeresgrundproben der Siboga-Expedition", p. 11). The bottom deposits of all the deep basins of the Archipelago are uniform in one fundamental fact, discovered by the Siboga Expedition. The mean quantity of $CaCO_3$ diminishes regularly with the increase of depth, at first comparatively slowly, but from 3500—4000 M. very quickly. At depths of more than 4000 M. most of the samples are completely free from calcareous matter, the mean amount being here only 2·1 p.c., as compared with 43·2 p.c. in water of 0—500 M. The corresponding figures for deposits obtained by the 'Challenger' in the open Oceans are consistently much higher; and, using those sent to me by Professor WEBER, those for comparatively shallow water, 0—900 M., are almost exactly twice as large (86·04 p.c.) as those of the Malay Archipelago, 0—500 M. Even at 3600—4500 M. the amount of $CaCO_3$ is slightly higher than at 0—500 M. in the Archipelago. The difference is due, according to BÖGGILD, to the large amount of terrigenous material derived from the numerous Islands of the Archipelago. It seems reasonable to suppose that the absence of Retepores in the Siboga dredgings made in the deep water of the Banda Sea is directly connected with the small amount of $CaCO_3$.

B. Geographical.

The deep water records of species obtained by the Siboga cannot be satisfactorily correlated with others, since few such records are available for adjacent areas. Japan stands almost alone in having a moderate number of abyssal records of Reteporidae. I do not lay much stress, therefore, on the fact that *Triphyllozoon bimunitum* and *Reteporella obtecta* were described, mainly from water of more than 100 fathoms, from Japan. *Sertella granulata* (p. 566), belonging to a genus represented by many species in both shallow and deep water of all the Oceans, has a more interesting distribution. It is a species with well marked characters and it is common, presumably in shallow water, off Victoria and South Australia. It occurs, still in shallow water, in Torres Straits; but further north it shows a tendency to become an abyssal species, having been recorded by CANU and BASSLER from Borneo, 175 fath. and the Philippine Is, 240 fathoms, and occuring in the Siboga Collection both in shallow water (Stat. 144) and in deep water (Stations 65ª and 98).

Most of the ramose species of Reteporidae probably belong to *Reteporella* or *Reteporellina*, but further study is required to show whether they can all be distributed among these two genera. They have a special concentration in the area from Torres Straits to Japan, from which more than half the known species were originally described, from both deep and shallow water. A smaller number of species are recorded from the Indian Ocean, as far as Mauritius and the Sudanese Red Sea; — the genotype of *Reteporella*, *R. flabellata*, having been described from Heard Id, 75 fath., and perhaps helping to explain the occurrence of *R. spatulifera* (WATERS, 1905, BCH, p. 243) from near Cape Horn. Two species were described by CALVET (see 1907,

BTT, pp. 454, 457) from near Gibraltar and W. Africa, 717—2330 M.; and another by CANU and BASSLER (1928, BGM, p. 124) from Yucatan, 130 fath. There is reason to suppose that *Reteporella* and *Reteporellina* are characteristic of the Siboga area and perhaps specially of the region to the north of it, since 7 species (possibly not all distinct) were described from Japan by ORTMANN (1889), OKADA (1920) and BUCHNER (1924); while CANU and BASSLER (1929) recorded 6 species from the Philippine Is. *Reteporella graeffei* was first described from the Fiji Is., and it appears to have been recorded, under this name or that of one of its synonyms, from Victoria, Tongatabu, the Great Barrier Reef, Torres Straits, the Gilbert Is. and Japan; and, in the Indian Ocean, from N. W. Australia, Ceylon and British East Africa. In the Siboga Collection it is one of the commonest Retepores, occurring in practically all parts of the Archipelago, mostly in shallow water. Specimens which I refer to this species occurred at depths of 270—522 M. in the Sulu Archipelago; and, if my synonymy is correct, it is found in deep water, up to 200 fathoms, off Japan. It is hardly possible to decide from these facts what was its original centre of distribution; but it seems to show the same tendency as that of *Sertella granulata* to descend into deeper water in the more northern part of its range in the Pacific. *R. obtecta*, the only other Siboga species of this genus, was described from Japan, 600 M. and has been recorded by CANU and BASSLER (1927, BIH, p. 28) from the Sandwich Is., 58—483 M. In the Siboga Collection it is represented by a fragment from the Kei Is., 204 M.

Reteporellina denticulata, originally described from the Sandwich Is., 20—40 fath., appears to have practically the same distribution as *Reteporella graeffei*, on the evidence of previous records and of specimens obtained by the Siboga in shallow water of most parts of the Archipelago. The other three Siboga species which I place in this genus were obtained only at Stat. 156, W. of Waigeu Id., 469 M. Two are new species, and the third, *R. laxipes*, was described by CANU and BASSLER from 108—530 fath. in the Philippine Is.

Iodictyum, a very distinct genus, known solely from the Western Pacific, is represented in this Report by 11 species, only 5 of which were found by the Siboga. The type species, *I. phoeniceum*, seems to occur only near the southern extremity of the range of the genus, off the S. coast of Australia and off New Caledonia. *I. willeyi* is from rather further north, occurring off the Loyalty Is. and New South Wales and in the China Sea. *I. spicatum* is represented solely by a fragment from Torres Straits. *I. sanguineum* is from Torres Straits, N. W. Australia, the China Sea and Japan. Three species, one of which, *I. buchneri*, was obtained on a reef at Stat. 131, S. of Mindanao, are otherwise known only from Japan or the Loochoo Is. *I. projectum*, the remaining species of Sect. A of the genus, was found by the Siboga at 7 shallow water Stations, 3 among the Southern Islands, 1 in the Strait of Makassar (S. of middle), 2 in the Celebes Sea, and 1 off the Kei Is.; and from 275—522 M. in the Sulu Sea. The determination of the minute colonies from the Strait of Makassar is probably but not certainly correct. The same species seems to have been recorded by CANU and BASSLER, as *Schizellozoon pheniceum*, from the Philippine Is., 29—240 fathoms. The 3 species of Sect. B are all represented in the Siboga Collection, and two of them are known from other localities; — *I. perarmatum* from Stat. 156, W. of Waigeu Id, 469 M.; *I. gibberosum* from Stat. 99 and 109, Sulu Archipelago, from Torres Straits and the China Sea, and from the type locality, Japan, 120 M.; and *I. polycrenulatum* from Stat. 105, Sulu Archipelago, 275 M., the Strait of Makassar

(S. of middle), Halmaheira and the Kei Is., in shallow water, as well as from the type-locality, Corea, 91—110 M. Including all the species of both Sections, the northern part of the range of the genus is predominant over the southern part.

Triphyllozoon is the genus most plentifully represented (by 13 species) in the Siboga area. Its range extends from the Western Pacific to the Indian Ocean [1]). In this genus there is undoubtedly a strong southern component, as shown by the 9 species and named varieties described by MacGillivray, Hincks and Busk from Victoria and South Australia, apparently all from shallow water. Some of the "varieties" appear to deserve specific rank (cf. Harmer, 1933, GR, p. 622), and other names are probably synonyms. In addition to these southern records there is also a strong northern component, since 8 Japanese species or varieties referable to *Triphyllozoon* have been described by Busk, Ortmann and Buchner, mostly from deep water. In the intermediate area, species or varieties have been described from the Great Barrier Reef, Torres Straits, New Guinea and the Philippine Is.; as well as from the Sandwich Is. the Crozet Is. and the more northern parts of the Indian Ocean. Of the Siboga species, *T. patulum*, *T. separatum* and *T. tuberculiferum* are deep water forms; and *T. bimunitum*, originally described from Japan, was obtained in deep water, as well as at depths less than 200 M. The remaining species were from shallow water, with rare exceptions of normally shallow water species at greater depths. Of the species first described from the Philippine Is., *T. mucronatum* occurs in the Siboga Collection off N. Celebes and New Guinea; *T. philippinense* was found at one Station (99) in the Sulu Archipelago; and *T. inornatum* (originally described as *Retepora simplex*) in various parts of the Archipelago. *T. hirsutum*, *T. tubulatum* and *T. benemunitum* (included by Busk under *T. tubulatum*) were originally described from Torres Straits, and these are all common in various parts of the Siboga area. I describe 3 others as new. At least two of the deep water species appear to belong to the northern component of the genus; those originally described from the Philippine Is. were found near that locality; and those first described from Torres Straits seem to have more southern affinities.

1) *Retepora monilifera*, forma *munita* has been recorded by Canu (1908, An. Mus. Nac. Buenos Aires, XVII, p. 290) as an Argentine fossil. No satisfactory evidence is given that the determination is correct, and it seems unnecessary to accept the record as proving that *Triphyllozoon*, to which the original species belongs, occurs in that locality.

II. DESCRIPTIONS OF SPECIES.

Order III. CHEILOSTOMATA (continued).

Sub-order II. ASCOPHORA.

Ascophora Levinsen, 1909, MSSB, pp. 12, 88, 213.

Fam. Reteporidae.

1. **Iodictyum** Harmer.

Iodictyum Harmer, 1933, GR, p. 624.
Retepora (pars) auctt.

Zoarium fenestrate (*I. spicatum* exceptional in being ramose), the calcareous parts brilliantly coloured (Section A) or white (Section B). Peristomes dimorphic, at first projecting, their orifices with more or less distinct marginal teeth and marginal denticles, but without spines. Descending lamina of ovicell produced into a projecting lip (labellum) bearing a median keel, generally terminating distally in a minute pore which is the only representative of a stigma. Small round and oval avicularia usually absent. Primary basal kenozooecia biserial. Genotype, selected by Harmer, 1933, *Retepora phoenicea* Busk, 1854.

Iodictyum, which I divide into two Sections, is sharply distinguished from other Retepores by the well developed, keeled labellum of its ovicell. The occurrence of either marginal teeth or denticles, respectively prolongations of the edge of the peristomial orifice and ingrowths just within the edge, is almost constant. The importance of this character is emphasized by the fact that, although these structures may be vestigial in most of the zooecia, they are specially distinct and strong in commencing colonies, which are very different from those described in *Sertella* and *Triphyllozoon*. The natural character of the genus is confirmed by the occurrence, in certain species, of gigantic, *vicarious*, infrafenestral avicularia, by the specially large frontal pores (Sect. A) and by the distribution, restricted, so far as is known, to the Western Pacific, from New Zealand and South Australia to Japan. A striking negative feature is the almost entire absence of typical small round and oval avicularia. The small frontal avicularia of *I. sanguineum* (p. 547) and the oval avicularia of *I. perarmatum* (p. 562) are those which most nearly correspond with these types.

The study of young zooecia, at or near the growing margin, is essential for the establishment of the distinctive characters of the species. The occurrence of two forms of peristome, one

completely tubular ("ordinary", see p. 521) and the other with a deficient distal wall ("fertile") is specially characteristic of *Iodictyum*. Differences in the opercula (p. 521) have not been satisfactorily correlated with the dimorphism of the peristomes. The sinus-groove which leads from the peristomial sinus to the proximal margin of the operculum (p. 519) is specially evident in *I. willeyi*. The arrangement of the kenozooecia (primarily biserial) and of the vibices of the basal surface is subject to great alteration as growth proceeds; and it is difficult to use their characters for the definition of species. The changes produced by the development of secondary kenozooecia, on both surfaces, are very marked. I have found the form and situation of the avicularia specially helpful in assigning specimens of *Iodictyum* to their proper species, but the opercula have been less useful for this purpose; — a conclusion previously reached by MARCUS (1921, SSEA, p. 15) for other genera.

Section A, the typical Section, including the genotype.

This Section includes all Retepores in which the calcareous skeleton has a bright colour which persists in dried specimens and in those kept in spirit; though fading may occur after a time. The pores are typically large and conspicuous, not more than 6, in 3 pairs occupying nearly constant positions in the zooecium. 7 pores occur rarely, and any one of the typical 6 may be wanting. The frontal avicularia appear to develop in connexion with the pores, almost any one of which may be associated with the appearance of an avicularium. The labellum of the ovicell and its associated structures are bilaterally symmetrical (cf. Sect. B). The operculum is thick and highly chitinized, often having a brilliant orange colour in the dry state. A marginal sclerite is sometimes recognizable and is generally best developed at its proximal ends, often fading away distally. The occlusor muscles are inserted at two points distant from the margin.

In the British Museum Catalogue BUSK (1854, p. 95) mentioned LAMARCK's reference to Retepores of a purple colour which had been brought from the mers d'Indè by PÉRON and LESUEUR; and added that they may probably be the species figured by RUMPHIUS. LAMARCK had given his record on p. 182 of the Hist. An. s. Vert. 1816, Vol. II; BUSK's reference, p. 277, being to the Second Edition, 1836, Vol. II. Although it almost certainly referred to *Iodictyum*, Sect. A, it is obvious that the species cannot be recognized unless the original material is in existence. The account of RUMPHIUS is given in "Het Amboinsch Kruid-Boek" (Amsterdam, 1750), VI Deel, XII Boek, XXV Hoofdst., Caput XXV, p. 247, Pl. LXXXVII, fig. 5. His figured specimen, described as *Reticulum marinum* and presumably from Amboina, is shown as 58 mm. across and 40 mm. high, and it is convolute and infundibuliform. In general appearance it closely resembles my own figures of *Triphyllozoon benemunitum* (Pl. XXXV, fig. 25) and *T. tubulatum* (fig. 30), species which were obtained by the Siboga at the Aru Is. Since RUMPHIUS described the colour as "flavescens", *Reticulum marinum* seems to be a probable pre-Linnaean synonym of one of those species and to have no claim to be placed in *Iodictyum*.

Section B.

The dry skeleton is not highly coloured; the pores are reduced in size and are less numerous, apparently wanting in certain zooecia. The labellum and lateral sinuses of the ovicell are asymmetrical. The operculum is delicate and is strengthened by a submarginal sclerite.

It would hardly have been possible to come to satisfactory conclusions with regard to the Siboga specimens of *Iodictyum* without examining others from different localities; and I have profited greatly by my study of those in the British and Cambridge Museums. With Professor WEBER's permission, I have included the results of this study in the present Report, though the specimens in question do not mostly come from the Malay Archipelago. Before describing the species to which I have paid most attention, I subjoin the following notes on *I. serratum* based on specimens from Victoria in the Cambridge Collection.

Iodictyum serratum (MacGill.).

Retepora serrata MacGillivray, 1883, PRSV, XIX, p. 287; 1884, PRSV, XX, p. 103, Pl. II, fig. 12 (operc., mand.); 1885, PZV, Dec. X, pp. 13, 31, Pl. XCIV, fig. 12 (operc.), Pl. XCIX, figs 9, 9*a*. Victoria.
Iodictyum (Retepora) serratum Harmer, 1933, GR, p. 625.

MACGILLIVRAY's figures of the ovicell are unsatisfactory. The labellum, in a Cambridge slide (Miss JELLY's Collection), is long and narrow, the distinct carina having a persistent frontal pore, the lateral sinuses being also long and narrow. The lateral flanges are narrow, flat continuations of the frontal surface of the ovicell, extending considerably beyond the labellum and uniting proximally. The labellum and its associated parts are practically symmetrical, but the carina may be slightly curved and the lateral sinuses are not always exactly equal. MACGILLIVRAY described the colour as "leaden grey".

This species is clearly referable to *Iodictyum*. The ovicell is almost symmetrical and thus does not conform completely with the definition given above of Sect. B. But in view of the characters of the opercula (see MACGILLIVRAY's figures, 1884, 1885), in which the sclerite is submarginal, I think it belongs to this Section.

Key to the species of *Iodictyum* here recorded[1]).

1	Zoarium brightly coloured; pores large; opercula thick, highly chitinized, the sclerite marginal or wanting; carina and lateral sinuses of ovicell symmetrical. (Section A)	2.
	Zoarium white or nearly so; pores small or evanescent; opercula thin, slightly chitinized, with indications of a submarginal sclerite; carina and lateral sinuses of ovicells asymmetrical (Section B)	10.
2	Section A	3.
3	Fenestrate	4.
	Ramose, probably not forming typical fenestrae; zooecia with long, wide, tubular, sinuate peristomes; frontal avicularia proximal, commonly forming vertical, spike-like projections in close relation with the preceding peristomes. Pink carmine	8. *I. spicatum* n. sp.

1) The characters given are those of young zooecia, not complicated by the development of secondary kenozooecia. The colours mentioned under species of Sect. A are those of dried or spirit specimens.

4	Peristome with a closed labial pore, on one side of which is the apex of a distally directed, oblique, acute avicularium. Crimson or carmine.	1. *I. phoeniceum.*
	Peristome with a proximal sinus.	5.
5	Peristomial orifice nearly or quite circular, with about 12 marginal denticles, its edge not or only slightly produced into marginal teeth.	6.
	Marginal denticles (other than the sinus-denticles) inconspicuous or wanting; marginal teeth recognizable	7.
6	Orifice quite circular, the marginal denticles specially conspicuous, equidistant; marginal teeth wanting; frontal avicularia common, boat-shaped, subimmersed, nearly longitudinal, directed proximally; fenestral avicularia not found. Rose-pink	7. *I. deliciosum* nom. nov.
	Orifice not quite circular, with marginal teeth; sinus very distinct, dilating proximally, constricted distally; frontal avicularia rare, raised, spatulate, directed obliquely; gigantic infrafenestral avicularia sometimes present. Reddish to purple, but subject to fading.	6. *I. axillare.*
7	Frontal avicularia very numerous, of moderate size, typically short and almost circular, the mandible wider than long (the avicularia occasionally longer, acute); gigantic infrafenestral avicularia sometimes present. Blood-red to purple	3. *I. sanguineum.*
	Frontal avicularia less numerous, acute, at least twice as long as wide	8.
8	Frontal avicularia large, wide, raised, occupying a considerable part of the surface of the zooecium, directed obliquely proximally or transversely; marginal teeth distinct on some peristomes; large fenestral avicularia may occur in any part of the fenestra. Carmine, purple or pinkish	2. *I. willeyi* n. sp.
	Frontal avicularia with a more restricted base, directed more or less proximally; marginal teeth obscure or wanting	9.
9	Avicularia short, not specially related to the peristome, wide proximally, mainly immersed but raised distally, absent on many zooecia; marginal teeth and denticles of peristome absent or vestigial; the orifice of one or both of the proximal zooecia of a fenestra directed towards the fenestra; gigantic infrafenestral avicularia present. Purple or violet	5. *I. buchneri* n. sp.
	Avicularia inconspicuous, immersed, narrow, reaching the peristomial orifice or slightly removed from it, occasionally lying along its proximal lip on one or both sides; marginal teeth often well developed; orifices of all fenestral zooecia normal; fenestral avicularia apparently wanting. Carmine or purple, fading to pink .	4. *I. projectum* n. sp.

10 Section B . . . . . 11.

11 { Fenestrae large, often 2 mm. long; avicularia numerous and of several kinds; small oval and large triangular, raised, on both surfaces; peristome exceptionally strongly toothed and denticulate, expanding at the orifice, which often has two long lateral projections. . . . . 11. *I. perarmatum* n. sp.

Fenestrae small, about 1 mm. long . . . . . 12.

12 { Avicularia frontal or wanting; peristomial orifices of peripheral zooecia at most with moderate marginal denticles; mature ovicells surrounded by a steep crater-wall . . . . . 10. *I. gibberosum.*

Avicularia labial or wanting; peripheral peristomial orifices with strong marginal denticles; mature ovicells deeply immersed. 9. *I. polycrenulatum.*

Section A.

Zoarium brightly coloured; pores large; carina and lateral sinuses of ovicell symmetrical; opercula highly chitinized, sometimes with a marginal sclerite.

In addition to the species described below, it is possible that *Retepora anatina* Ortmann (1889, JB, p. 33, Pl. II, fig. 16), a Japanese species with very large duckbill-like avicularia, may belong to Sect. A. of *Iodictyum*. This is suggested by its reddish tinge and by the conspicuous marginal teeth of the peristome, as figured by Ortmann. On the other hand, the ovicell in his figure does not show the characters typical of this genus; — but it may have been broken or in an immature condition.

1. *Iodictyum phoeniceum* (Busk). (Pl. XXXV, fig. 1; Pl. XXXVI, figs 4, 6—9).

Retepora phoenicea Busk, 1854, BMC, p. 94, Pl. CXXI, figs 1, 2. Bass Strait; 1884, Chall., p. 124, text-fig. 34 (operc., mand.). Bass Strait, 38 fath.
Retepora phoenicea Hincks, 1878, GR, p. 362. S. Australia.
Retepora phoenicea MacGillivray, 1884, PRSV, XX, pp. 103, 112, Pl. II, fig. 13 (operc., mand.); 1885, PZV, Dec. X, p. 27, Pl. XCVIII, figs 1—5 (fig. 1, zoarium); Pl. XCIV, fig. 13 (operc.). Victoria.
Retepora phoenicea Cumings, 1904, DPB, p. 71; 1905, DF, p. 170, Pl. VI, figs 27—29 (ancestrula). S. Australia.
? *Retepora phoenicea* Livingstone, 1929, BCNZ, p. 91. New Zealand, 50—55 fath.

British Museum: —

Type. Bass Strait (Rattlesnake Coll.), G. Busk, 54. 11. 15. 167 (slide); 99. 7. 1. 69 (large colony and slides prepared from it) and other specimens from Victoria and S. Australia.
Duroc Id. (New Caledonia), 62. 2. 4. 28.

Cambridge, Mus. Zool.: —

Victoria (Port Western, Port Phillip), Miss E. C. Jelly, Reg. May 24, 1895.
S. Australia, T. Hincks, Reg. May 13, 1899.
Adelaide, 20—35 fath., Sir J. C. Verco, Reg. Mar. 16, 1904.
Locality? — Saul Coll., Reg. Dec. 14, 1895.

Zoarium (Pl. XXXV, fig. 1) rich crimson or carmine, large, closely convolute, in parts infundibuliform. Fenestrae [1]) ·9 × ·6 mm., subcircular, oval or slit-like, usually narrower than the 3—7 serial trabeculae. Septal ridges not very prominent, the convex frontal shield occupying most of the hexagonal area; marginal valleys narrow; pores usually 2 : 2, small. Peristomial orifice smooth or with more or less prominent marginal teeth, but without marginal denticles; a small labial pore close to its margin. Primary frontal avicularia immersed, broadly triangular, acuminate, directed obliquely distally, the apex reaching the peristomial orifice on one side of the labial pore. Special fenestral avicularia not found. Ovicell longer than wide, the labellum descending steeply, long, nearly parallel-sided, its carina low, bordered by lateral slits but with hardly distinguishable lateral sinuses.

Opercula (Pl. XXXVI, fig. 9) wider than long, marginal sclerite slight, the proximal border with a wide and shallow sinus. Mandibles with a wide base, nearly or quite as long as the sides, which are curved inwards, the apex with a small, acute point.

My list of synonyms is short, since many of the records of *Retepora phoenicea* do not belong to this species, and other accounts fail to indicate the characters by which it can be recognized. The most important of these are the immersed, distally orientated primary frontal avicularia; the occurrence of a labial pore even at the growing margin, occasionally shifted to one side by the avicularium; the relatively inconspicuous septal lines and pores of the frontal surface; and the form of the opercula, which are wider than long. In nearly all these characters *Iodictyum phoeniceum* differs from the other species here described. Stages in the early development of the colony (Pl. XXXVI, fig. 4) are described on p. 508.

It has sometimes been stated that avicularia are not developed on the youngest zooecia of Reteporidae. I believe this to be a mistake; and I find that the primary frontal avicularia develop with the zooecia to which they belong, at the growing margin. They are present in a large proportion of the zooecia in *I. phoeniceum* and are very constant in their characters (fig. 7). The sides of the rostrum are often incurved, and the transverse bar sometimes forms a minute median emargination projecting into the rostral opesia.

As in other species, the zooecia and other parts become greatly altered by secondary calcification, which results in a thick frontal wall, in which the pores either remain small or become slightly larger. New avicularia make their appearance, differing from the primary avicularia by their inconstant orientation and in being often raised instead of immersed.

Ovicells of all ages are represented in the material I have examined. Their development agrees with the account given on pp. 522—524, but the rhomboidal form of the frontal vacuity, in the immature stage (fig. 8, *c*) is noteworthy, and may prove to be characteristic of this species. The labellum is trough-like, with raised lateral edges. Its apparent shortness in my figure, which closely agrees with MacGillivray's (1885, fig. 4) is due to the fact that it is foreshortened, owing to its steep descent into the peristome. The frontal end of the low carina sometimes forms a definite projection surrounding the pore which, as in other species of *Iodictyum*, is commonly situated in this position. The lateral slits are surrounded, frontally, by low, semicircular,

1) The fenestrae of Reteporidae vary in size, even in the same colony. The measurements given, here and elsewhere, indicate sizes actually observed but are not completely representative of the species. The number of series of zooecia is counted at about the middle of a trabecula, but larger numbers occur at the proximal or distal ends of some fenestrae.

calcareous ridges. Like other parts, the ovicells may become concealed by secondary kenozooecia. When they are numerous and close together, secondary avicularia may be formed among them, often filling the valleys between them (fig. 8, *d*).

The basal surface of the trabeculae is very convex, the tubercles moderate, numerous, sometimes elongated so as to give a crumpled appearance to the surface. Some of the primary kenozooecia are large or elongate on the distal side of a fenestra (fig. 6). Basal avicularia, resembling those of the frontal surface, are frequently found on the fenestral margins or on the general basal surface. Secondary vibices often divide the surface into much more numerous, very irregular, small kenozooecia (one or two shown in fig. 6), each of which may have one or two basal pores, which are wanting in the primary kenozooecia. Similar avicularia occur on the basal plate, at least in young colonies.

Two opercula were figured by MacGillivray (1884, 1885); and one of them is distinctly wider than long. Like Busk, I have found only this wide type (fig. 9, *O*); but in this species (although not in most others) the opercula stand almost vertically at the bottom of the peristome and are thus usually seen edgeways unless they are dissected out completely. The mandibles also agree well with that figured by Busk (1884, p. 124); and in their almost equilateral form they are unlike those of other species. For a mistaken criticism of Busk's figure by Waters see p. 545, under *I. willeyi*.

The British Museum possesses about 6 specimens from Busk's collection, all from Bass Strait, Victoria or "Australia". The one labelled as "Type" is the slide 54. 11. 15. 167. Many years later, on Busk's death, the Museum received the large colony, 99. 7. 1. 69 (which I have figured, Pl. XXXV, fig. 1), also from the 'Rattlesnake' Collection. It is about 70 mm. wide, much convoluted and with infundibuliform lobes. I have made preparations from it which correspond so closely with slide 54. 11. 15. 167 that this colony may fairly be assumed to have been the one from which that slide was also made, and that it is the actual type of the species. My preparations clear up several difficulties in the original description. Busk's fig. 1 (1854), showing an avicularium, was drawn in such a way as to leave some doubt which is the rostrum and which is the mandible. It is quite clear from his slide that the figure was intended to represent an immersed avicularium distally orientated, the open mandible being directed proximally. Busk's fig. 2 shows ovicells which are either immature or at least do not represent the labellum. His fig. 1 indicates obscurely the "concentrically marked operculum" with covers the young ovicell "in front" (his text, p. 95). This is of course the entooecium in its early, concave condition, when it is marked by about 4 or 5 concentric ridges (Pl. XXXVI, fig. 7). These are conspicuous in the present species, although equally characteristic of others. Busk neither figured nor described the closed labial pore, which can be clearly seen in his type-slide. While many zooecia have a nearly circular secondary orifice, the fertile orifices are often rather more prolonged, as shown by Busk's fig. 2; but here again labial pores may be detected in the original material, though it seems probable that an open sinus may occur in a few of the ovicell-bearing zooecia; — a condition which in any case is rare.

Busk's specimen is the type both of the species and of *Iodictyum*. Its growing margin shows relatively wide zooecia, their frontal surface convex and nearly filling the hexagonal areas. The pores are paired, typically 4; one pair at the extreme proximal end, the other

nearly at the middle of the length of the zooecium; and one or more of these pores may be wanting. 3 pores rarely occur on the same side. The edge of the peristome is toothed, the projections short but often strong, and there are no marginal denticles. Even at the growing margin the labial pores are nearly always closed, though rarely showing their mode of origin by the union of the sides of a sinus.

All the coloured Retepores I have examined from Victoria and South Australia belong to *I. phoeniceum*, which I have found from no other locality except "Duroc Reef". From information given by the Admiralty, this appears to be Duroc Island, near the Isle of Pines, New Caledonia. I have no means of deciding whether LIVINGSTONE's record (1929, BCNZ, p. 91) of *Retepora phoenicea* from New Zealand is correct; though this seems to be probable.

2. *Iodictyum willeyi* n. sp. (Pl. XXXV, figs 3, 4; Pl. XXXVI, figs 16—24, 29).

Retepora phoenicea Waters, 1887, BNSW, p. 197, Pl. VI, figs 15, 20 (operc., mand.).
Retepora phoenicea Philipps, 1899, WZR, pp. 440, 448 (no description). Lifu, Loyalty Is., Willey Coll.
Retepora phoenicea Kirkpatrick, 1890, CS, p. 17 (no description). China Sea, 35 fath.

British Museum: —

New South Wales, Dr. J. G. JEFFREYS, 76. 10. 14. 41.
Locality? — Capt. Belcher, 51. 11. 14. 73.
Macclesfield Bank, China Sea, 35 fath. BASSETT-SMITH Coll., 93. 8. 11. 23; ibid., 26 fath., N° 2. 89. 8. 21. 20.

Cambridge, Mus. Zool.: —

BM (part) Type. Lifu, A. WILLEY Coll., Reg. Mar. 1, 1898.
Port Jackson, New South Wales, Miss E. C. JELLY, Reg. May 24, 1895.

Zoarium (Pl. XXXV, figs 3, 4) brilliantly carmine-pink or purple, convolute, infundibuliform. Fenestrae 1·5 × ·9 mm., oval or elongate and then wide or slit-like, about equal in width to the 3—6 serial trabeculae. Septal ridges (Pl. XXXVI, fig. 16, *S.R*) high, marginal valleys distinct, usually with 2 pairs of pores of moderate size, sometimes with 3, 5 or 6 pores. Frontal shield moderately convex proximally, passing gradually, without angular change of direction, into the peristome, the distal wall of which originates well within the septal ridge. Orifices of tubular (ordinary) peristomes nearly circular, except for a projection enclosing a very distinct sinus. Orifices of fertile peristomes subtriangular, often wider than long, the sides diverging distally, the edge even or variably produced into small marginal teeth; sinus-denticles distinct, others wanting. Primary frontal avicularia moderately numerous or rare, large, forming mound-like swellings, the triangular, acute rostrum ascending; orientation transverse or obliquely proximal or distal; apex decurved, but exceptionally with a vertically upstanding beak. Marginal avicularia vicarious, infrafenestral, suprafenestral or, if lateral, distally orientated, not specially large, mainly immersed, the rostrum and mandible moderately wide and acute. Ovicell usually wider than long; the labellum not vertical, truncate-triangular, bordered by narrow lateral slits in the distinct lateral sinuses, its carina weak, diminishing basally.

I name this species after Dr A. WILLEY, F.R.S., who obtained the very beautiful young colonies on which my account is mainly based. The New South Wales specimens are older and

differ from the type in their rather smaller fenestrae with wider trabeculae, and in their less inflated frontal avicularia. The basal part of the frontal avicularia from Lifu (Pl. XXXVI, figs 19, 20) is greatly swollen, generally covering most of the frontal shield. In those from Port Jackson (fig. 22) the base is less extensive, so that much of the frontal shield remains exposed. Their rostra and mandibles (fig. 29) and those of the fenestral avicularia are smaller and narrower than in the Lifu material (fig. 21).

WATERS (1887, Pl. VI, figs 15, 20) presumably figured an operculum and a mandible of the present species, although he assigned them to *Retepora phoenicea*. He did not indicate their locality, but in his text he mentioned Victoria, South Australia and Port Jackson. He thought there must be "some mistake with BUSK's figure of the operculum", as it did not correspond with any he had seen; and CANU and BASSLER (1929, BPR, p. 370) have observations on the same subject. BUSK had given correct figures, however, of the real *Iodictyum phoeniceum* from Victoria (*supra*, p. 543) and it may be assumed that WATERS' figures were from his Port Jackson material and that they refer to the present species. The markings he showed near the middle of the operculum were probably parts of the associated membranes; and, if this be admitted, there is no substantial difference between his figures and mine from the same locality (fig. 29).

The growth of the zooecia at the margin of the colony (fig. 16) takes place as described, partly from the Lifu material, on p. 515. The pores do not increase much in size as calcification proceeds, so that a considerable amount of smooth calcareous substance separates them. The peristomes become immersed, the part with the sinus continuing to project for a time. The frontal avicularia (Lifu) are rare in some colonies; and those which partially overlie an ovicell indicate the covering of that structure by secondary contributions from adjacent zooecia (see p. 524). Fig. 16 shows that the fenestral avicularia, which also occur in the Port Jackson specimens, are vicarious, as is seen also in the case of the mature, distally directed fenestral avicularia shown in fig. 19. Other marginal avicularia are present on the proximal or distal sides of the fenestrae. As in other species, the fenestrae of a single lobe may progressively alter in size and shape. Fenestrae were found at the proximal end, ·8 × ·4 mm., narrower than the trabeculae. More distally they are larger, some slit-like and others wider than the trabeculae.

Developing ovicells in all stages occur, including conditions practically identical with those of *I. sanguineum* (text-figs 26, 27, p. 522). The labellum of the adult structure (Pl. XXXVI, figs 17, 23) is less vertical than in *I. phoeniceum* and is therefore more easily seen. It is generally an acute-angled triangle, truncate at the deeper end. The lateral slits are straight and sometimes easily visible, and the lateral flanges are narrow. A pore persists, as in other species, at the frontal end of the carina, partly surrounded by a slightly projecting calcareous edge; the carina being rather low.

Some of the Lifu colonies are purple-red and differ from the others which are paler and pink, and in having extremely few frontal avicularia, found with difficulty. Their basal vibices and the frontal septal lines are exceptionally white, and therefore specially distinct; and the frontal pores are larger than in the pink colonies.

The primary basal kenozooecia are more regularly arranged than in most of the other species. They are short near the base of the colony, where the fenestrae are oval (fig. 18). More distally, the fenestrae are longer and the most elongate kenozooecia are those round their

distal margins. There is a tendency, not universal, to produce two specially large kenozooecia in this position. The tubercles are rather large and closely approximated.

The specimens from Port Jackson are much older, as shown by the extensive development of small secondary kenozooecia on both surfaces. They differ in appearance from those just described, but this is probably a question of age. Frontally, the older parts have many irregularly disposed kenozooecia, which ultimately cover and obliterate the avicularia, and later the orifices of the peristomes. Basal avicularia are nearly always wanting in this species, but in specimens from both localities there are groups of secondary kenozooecia (fig. 24), each generally with 1—6 conspicuous pores; and avicularia resembling those of the frontal surface have been found, very rarely, on these. In a fragment including the base of a colony (Lifu) certain fenestrae were reduced in size by kenozooecia, which would probably have obliterated them later.

Slight differences occur in the chitinous parts of the specimens from the two localities. The opercula from Lifu (fig. 21) are the smaller. The longer kind is more regularly oval; and, although convex proximally, the wide sinus is generally less marked than in some from Port Jackson (fig. 29). The shortest ones from Lifu are subcircular, with a straight proximal edge. The marginal sclerite is weak and may be incomplete. The mandibles differ merely in their proportions, as shown by the two figures. Those of the fenestrae are longer than the frontal ones but they have the same general form.

Some of the Lifu colonies bear very numerous specimens of *Loxosoma*, which I have not determined.

Two purple-red colonies from the China Sea are referred to this species. The fenestrae are large (1·5 × 1 mm.) and considerably wider than the trabeculae. The pores, when calcification is advanced, are conspicuously large and are separated by narrow bars. The frontal avicularia, which have become immersed, have the same shape, size and orientation as in those from Port Jackson; and several large infrafenestral avicularia are visible on the frontal surface.

3. *Iodictyum sanguineum* (Ortmann). (Pl. XXXV, fig. 2; Pl. XXXVII, figs 10—16; text-fig. 25, A, p. 519; text-figs 26, 27, p. 522).

Retepora sanguinea Ortmann, 1889, JB, p. 34, Pl. II, fig. 17. Japan.
Retepora sanguinea Buchner, 1924, UJR, p. 203, Pl. XVI, fig. 11. Japan.
Retepora phoenicea Kirkpatrick, 1890, TS, p. 612 (no description). Torres Straits, 15—20 fath.
? *Retepora phoenicea* Meissner, 1902, ATIB, p. 731 (no description). Torres Straits.

British Museum: —

Torres Straits, 15—20 fath., A. C. Haddon, 90. 3. 24. 89 (recorded by Kirkpatrick, 1890, as *R. phoenicea*).
Japan, Enoshima Id. Dr Burge, 83. 8. 17. 3.
Japan. Dr Anderson, 34. 1. 2. 1, 2.
China Sea, Holothuria Bank, 15 fath. Bassett-Smith Coll. 92. 1. 28. 109.
N. W. Australia, Baleine Bank, 10—15 fath. Bassett-Smith Coll. 92. 1. 28. 108.

Cambridge, Mus. Zool.: —

Torres Straits (part of Dr Haddon's Collection, received from the British Museum). Reg. May. 26, 1900.

Zoarium (Pl. XXXV, fig. 2) blood-red (or dull purple, probably faded), slightly contorted, sometimes at least with large wide lobes. Fenestrae (about 1 mm. long) oval or slit-like, generally narrower than the stout 3—6 serial trabeculae. Septal ridges strong, marginal valleys narrow, pores 4—6. Ordinary peristomes shortly tubular, the orifice toothed marginally, circular except for the small sinus; fertile peristomes bilabiate; all later almost entirely immersed, the pores usually increasing greatly in size, the frontal surface then appearing reticulate. Frontal avicularia very common, on one side of the zooecia, of moderate size, their edge slightly raised, almost circular, divided by the calcareous bar into two approximately equal halves (the rostrum more elongate in specimens described below). Gigantic infrafenestral avicularia (not always found) frontally, the rostrum long, wide throughout and rounded terminally. Ovicells usually wider than long, later immersed; sometimes crossed by a secondary distal lip of the peristome and more frequently by two oblique vibices meeting at the frontal end of the carina of the labellum, which is not vertical, often narrowly triangular, its carina strong (sometimes reduced), generally retaining the frontal pore or fissure. Basal avicularia very rare.

The zoarium, as described by Ortmann, is blood-red; and specimens in the British Museum from the type-locality (Japan) are of this colour. Buchner described Japanese material as blue-red, and those from Torres Straits, here considered, are dull purple. It is probable, in view of Okada's statement (1920, RAJ, p. 621) referring to *I. axillare*, that fading has taken place in some of the dried specimens.

The typical *I. sanguineum* is at once recognizable by the characters of its frontal avicularia (Pl. XXXVII, fig. 15) and by the profusion in with they are developed. Ortmann described either one or two on a zooecium; but, in the material from Japan and Torres Straits, I have rarely found more than one. As in the other species of *Iodictyum*, the avicularium develops in connexion with one of the marginal pores, which doubtless supply the necessary nutrient material; — in accordance with Jullien's conception of "origelles" (1886, Bull. Soc. Zool. France, XI, p. 607 n.). The avicularia of this species being of moderate size, it can be clearly seen that each stands directly over one of the large pores. They are short, erect columns, nearly circular in horizontal section, the truncate free surface occupied by the palatal portion, the edge of which is raised all round. In vertical longitudinal section the avicularium would have the shape of a low M, the calcareous bar corresponding with the median point of the letter and dividing the structure into two equal halves, inclined towards one another. The proximal half is a segment less than a semicircle; and the rostral half, recognizable as a weak Gothic arch, is directed outwards, usually with some obliquity, proximally or distally. Although the avicularium may become almost completely immersed, both halves, particularly the rostrum, continue to project slightly for some time.

The young zooecia (text-fig. 26, p. 522) are outlined by deep, very distinct septal ridges (S.R), enclosing shortly hexagonal or parallel-sided areas, each mainly occupied by a very convex frontal shield, sometimes nodular proximally, and continued without abrupt change of direction into the smooth peristome. The ordinary peristomes (text-fig. 25, A. p. 519) have an even or slightly toothed, circular orifice, the teeth often directed inwards in the older condition. These may be ridged internally, and if the frontal ends of the ridges are sufficiently prominent they may appear as marginal denticles. Two sinus-denticles occur, as in other species, in all the

peristomes. The fertile peristomes are often bilabiate (text-fig. 26, p. 522), the two lips diverging from the sinus and being much raised laterally. The secondary orifice is in this condition sometimes pyriform; but this shape may be modified later, partly by an unequal thickening of the calcareous wall, and partly by a slight prolongation of the length of the tube; these changes resulting in a mainly circular, but sinuate, secondary orifice, in the older parts. The fertile peristomes generally have about 3 marginal teeth on either side, more strongly developed than in the ordinary ones.

As calcification progresses, the peristomes become almost entirely immersed. In the Torres Straits material (Pl. XXXVII, fig. 15), but not so much in the Japanese specimens, there is a notable increase in the size of the pores, which become so large that the surface is reticulate. The pores are then separated by narrow bars, some of which differ from the others in being traversed by the original septal lines. When an ovicell has become almost immersed, as frequently happens, two pores on its distal side are commonly very large (fig. 15).

Fenestral avicularia are not easily found in the Torres Straits material; but one or two occur on the proximal sides of fenestrae, as shown in fig. 14.

The development of the ovicell (text-figs 26, 27, p. 522) is described on p. 523. The mature ovicell (fig. 27, DO) generally appears wider than long, but its proximal part is often concealed in the peristome; and the primary ovicell may be as long as wide. The truncate, triangular labellum is not steep, so that its details can be seen more easily than in *I. phoeniceum*. The carina is typically high, fading away at its basal end. The lateral slits (*L. Sl*) are generally concealed by the lateral flanges (*L. Fl*).

The basal surface has specially prominent, round tubercles; but, as is usual in the genus, it is smooth or granular in the young condition. The two marginal pores of each primary kenozooecium correspond with the lateral septula of the zooecia; and the two sets are closely apposed, lying deeply in the fenestrae. Basal avicularia are nearly always wanting, but I have found one, rather longer than the frontal avicularia, which it resembles. The primary basal vibices (Pl. XXXVII, fig. 11) are conspicuous, dividing the surface into areas in much the same way as in *I. willeyi*, but with a rather more irregular arrangement. As in that species, there are frequently two larger kenozooecia at the distal end of a fenestra; and a single primary kenozooecium rarely reaches two fenestrae. Recognizable secondary basal kenozooecia are hardly represented in my slides from Torres Straits.

The foregoing description is based mainly on the Torres Straits specimens, which are almost from the Siboga area and agree closely with the Japanese specimens except in their colour. In both localities the frontal avicularia are practically identical and equally numerous, and they are nearly always developed, moreover, from the distal pair of pores, which are large and conspicuous in both cases. The principal respects in which the Japanese specimens differ from those of Torres Straits are as follows. The marginal teeth are rather stronger in the former; the longitudinal ridges of the peristome are also more developed, their frontal ends appearing as about 10 denticles, in addition to the two sinus-denticles, which are slightly stronger than the others. After the completion of the ovicell the lateral lobes of the peristome sometimes become connected by a distal piece which crosses the ovicell, and the peristome is thus secondarily tubular. The primary basal kenozooecia agree in form with those from Torres Straits

(fig. 11); and are, as usual, devoid of basally situated pores. In somewhat older branches, numerous small and irregular kenozooecia, separated by weak vibices, may occur. In still older parts their vibices are at least as strong and conspicuous as the primary ones; but, while approximating to them in size, their arrangement is different. The primary biserial arrangement is less constant; and, if it occurs, the median vibex of a trabecula (which may be straight) is often strongly zigzag. It is frequently deficient, so that a kenozooecium crosses the trabecula from one fenestra to another; or the deficiency may be of such a kind that a kenozooecium reaches three fenestrae. Some of these areas can be recognized as secondary by having basal pores. It is not always possible to distinguish between the primary and secondary kenozoocia of a Retepore; but some assistance is given by the fact that, as in the present species, while the primary structures are bright red the secondary kenozoocia are, or may be, much paler; — yellowish in this instance, frequently white in others.

The opercula and mandibles are bright orange in the dry condition and are highly chitinized. The opercula (Pl. XXXVII, figs 10, 13) are oval, with some variation in width; and the marginal sclerite is often very obscure. The frontal mandibles are obviously loosely attached; since, although they may be seen lying on the surface of a dry specimen, they are mostly lost during the processes of decalcifying and mounting. Their outline is a segment less than a semicircle, or triangular (fig. 13, Japan), but in those of the specimens indicated below they are longer and acute. The infrafenestral mandibles from Torres Straits (fig. 10) are large, rounded distally and asymmetrical, in agreement with the form of the rostrum (fig. 14); but basal fenestral mandibles found in the following specimens are narrow and acute, as shown by the avicularia of fig. 12. I have not found fenestral avicularia in the Japanese specimens, but it is hardly possible to be certain that these structures are absent.

The fine, convoluted colonies from the China Sea and N. W. Australia have wide lobes, not much curved and a small number of broadly expanding funnels. The one from the Holothuria Bank (Pl. XXXV, fig. 2) is 53 mm. high, 68 mm. across and is brownish purple. The Baleine Bank colony is 55 × 50 mm. and is of a pinker purple colour. In both, the frontal avicularia are specially numerous, their orientation from transverse to completely proximal (Pl. XXXVII, fig. 16). While in the Torres Straits and Japanese specimens the avicularium is nearly always developed by a distal pore, it is frequently on a proximal pore, though sometimes on a distal pore, in the Baleine Bank colony. The Holothuria Bank specimen (fig. 16) has them in even greater profusion; — often two on one zooecium, one on a proximal pore and one on a distal pore; or both on pores belonging to the same pair. They differ from the typical *I. sanguineum* in being nearly all elongate, with a narrowly triangular and acute rostrum and mandible. A few shorter rostra may be found, however; and they partly bridge the gap between these and the typical avicularia. In both specimens many elongate avicularia with very narrow rostra (fig. 12) are visible in basal view, principally on the margins of the fenestrae, often deep down, but sometimes on the basal surface. Their orientation is not constant, and they may occur at either end of the fenestra or laterally.

4. *Iodictyum projectum*[1]) n. sp. (Pl. XXXV, fig. 6; Pl. XXXVI, figs 2, 3, 10—15).

Schizellozoon pheniceum Canu and Bassler, 1929, BPR, p. 370. Pl. XLVIII, figs 1—5. Philippine Is., 29—240 fath.

Group A. ? sp. 388. E. Stat. 81. Borneo Bank, Str. of Makassar, 0—34 M. 2 colonies, in initial stages.
247. B. Stat. 310. Sumbawa, E., 73 M. 1 col.
35. A. Stat. 66. S. of Saleyer, 8—10 M. Fragments, old.
Type. 271. A. Stat. 60 & 303. Haingsisi, Samau Id., W. Timor, 0—36 M. 1 large col.
Group B. 79. E. Stat. 105. Sulu Archipelago, 275 M. (Old and worn fragments, probably this species).
469. B. Stat. 95. Sulu Archipelago, 522 M. Colony in initial stage. (On slide 469 A. *Triphyllozoon inornatum*).
485. A. Stat. 123. Biaru Id., N. E. of Celebes, 27—36 M. Fragments.
? sp. 488. E. Stat. 133. Lirung, Talaut Is., S. of Mindanao, 0—36 M. Fragment.
Group C. ? sp. 177. C. Stat. 257. Kei Is., 0—52 M. 1 col.

British Museum: —

Philippine Is., Tawi-Tawi Is., 240 fath., sent by CANU and BASSLER as *Schizellozoon pheniceum*. 31. 12. 30. 136.

Zoarium (Pl. XXXV, fig. 6) deep carmine or purple, fading to pink, saucer-shaped, somewhat convolute, not infundibuliform. Fenestrae variable, 1·5 × ·7 mm. or smaller, generally longer than wide, sometimes slit-like, narrower or wider than the 2—5 serial trabeculae. Septal ridges moderately prominent, enclosing areas principally occupied by the frontal shields; marginal valleys indistinct or narrow and of moderate depth; pores usually 4—6. Frontal shield convex, passing gradually into the peristome, which is moderately raised and thick-walled. Secondary orifice mainly circular, the sinus defined by two strong sinus-denticles; its edge variable, smooth or with marginal teeth and denticles. Peristomes later immersed, the edge projecting for some time; the pores remaining distinct, with some increase of size. Frontal (or labial) avicularia inconspicuous, unilateral; the proximal end, with one of the sinus-denticles which it overlies, forming a pointed, triangular projection into the peristome; or, less often, slightly removed from it or even lying along its proximal margin; the rostrum acute, immersed, usually directed proximally and slightly outwards, sometimes with a short raised beak. Fenestral avicularia not found. Ovicells often wider than long, usually crossed by two vibices, the labellum oblique (not vertical), its carina highest frontally or at the middle of its length, commonly with a persisting frontal pore. In some instances the ovicell is produced distally into a median lobe between the two proximal pores of the succeeding zooecium (Pl. XXXVI, fig. 13), but other ovicells are regularly globose (fig. 11). Basal avicularia not found.

I. projectum is characterized by its frontal or labial avicularia, inconspicuous and liable to be overlooked. Its colour is less permanent than that of some other species. 485. A, which was mounted soon after the receipt of the collection, has a colour as intense as that of *I. phoeniceum*, and it is more highly calcified than some of the others. 35. A was at first of varying tint and intensity, crimson to purple, but the colour has almost disappeared in the mounted slide. 177. C is brilliantly carmine. The old fragment 488. E, originally of a deep crimson colour, is now faded. The best colony, 271. A (type) was 40 mm. in its longest diameter and of a nearly flat but wavy growth (Pl. XXXV, fig. 6). When first examined it had a distinct and fairly deep crimson colour, but it has faded to a light pink.

1) In allusion to the projection of the avicularium into the peristome.

The fragment sent to the British Museum by Messrs CANU and BASSLER (as *Schizellozoon pheniceum*) is old and in poor condition, but it has a sinuate peristome and the frontal avicularia characteristic of the present species. It does not confirm their statements that the pores are "never symmetrically arranged" and that the avicularia agree in orientation with those of *I. phoeniceum* described by HINCKS.

The adult orifices (Pl. XXXVI, fig. 15) are commonly pyriform, and a large proportion have no distinct teeth or denticles. Some peristomes have recognizable marginal teeth or internal ridges sufficiently developed to form about 8 weak denticles, often most distinct distally. The proximal end of the frontal avicularium typically projects into the peristome (fig. 15), but fails to reach it in a few zooecia. The labial avicularia shown in fig. 11 were found solely in 247. B, but other avicularia in the same colony are of the more usual type. The labial avicularium seems to be a displaced frontal avicularium, or vice versâ, the two kinds not occurring on the same zooecium. Its palatal surface faces obliquely distally and frontally, the narrow beak of the triangular rostrum reaching the peristomial sinus and frequently displacing it to the other side of the median line. A fertile zooecium usually has a single avicularium, but in one or two instances there are two symmetrical labial avicularia, the beaks of which meet on the frontal side of the peristomial sinus. In the young condition the avicularium forms a considerable swelling dilating one side of the peristome.

The young colonies 388. E. (figs 2, 3) and 469. B, probably belonging to this species, and giving important evidence with regard to the initial stages in the growth of the Reteporidan colony, are described on p. 507 et seq. I have also found two solitary zooecia on trabeculae of 271. A; but these have fully adult characters and appear to be regenerated zooecia which have been separately formed on old branches.

177. C differs from the others in being somewhat Reteporelliform in appearance, and its reference to the present species is doubtful. It is 10 mm. across and includes the base, from which arise about 8 diverging 3—5 serial trabeculae; and only one fenestra (2·5 × 1 mm.) has been formed. The ends of some branches are lost and it is uncertain whether other fenestrae were present or would have been developed. It agrees with the type in most characters, including those of the pores, peristomial orifices and avicularia; but many of the peristomes, particularly the marginal ones, are surrounded by a thick tube of secondary calcareous matter. The frontal shields also seem to be specially thick.

79. E, in poor condition and obviously dead when found, is referred to this species on the evidence of a frontal avicularium, confirmed by the large pores and other characters. It may perhaps have grown in shallow water and have been drifted into the deeper position in which it was dredged; but the evidence of 469. B (found in deeper water) does not confirm this suggestion.

The primary basal vibices are weak, enclosing kenozooecia regularly arranged in the typical biserial manner (fig. 14) and having numerous small tubercles. Small basal kenozooecia occur in 271. A. and are probably secondary, as shown by the presence of basal pores. The basal surface of old branches is strongly tubercular, the vibices are more prominent, and large kenozooecia reaching more than one fenestra are sometimes present.

The opercula (figs 10, 12, O) are variable in length and width, sometimes nearly oval or wider distally, slightly convex or straight proximally; and have a feeble marginal sclerite. The mandibles (*M*) are short, wide at the base and acute.

5. *Iodictyum buchneri* n. sp. (Pl. XXXV, fig. 7; Pl. XXXVII, figs 1—5).

Retepora axillaris Okada (pars), 1920, RAJ, p. 621. Loochoo Is. [1]).
Retepora axillaris, var. *okada* Buchner, 1924, UJR, p. 200.

Group B. Type. 100. A. Stat. 131. Talaut Is., S. of Mindanao, reef. 1 col.

Zoarium (Pl. XXXV, fig. 7) purple or violet, saucer-shaped, slightly convolute. Fenestrae elongate (about 1·5 × 1 mm.), rather wider than the 2—6 serial trabeculae. Septal ridges thin, conspicuously high and distinct; marginal valleys wide, the commencing convex, thin-walled peristome occupying a relatively small part of the hexagonal area. Pores often 4, but frequently 6 or 5, enlarged and conspicuous when calcification is advanced. Peristomial orifice mainly circular with a projecting sinus, completely smooth in most zooecia, rarely with obscure vestiges of marginal teeth or denticles, with the exception of the two small sinus-denticles which occur constantly. Proximal marginal zooecia, on one or both sides of most fenestrae, with an unusual orientation (Pl. XXXVII, fig. 3); the orifices of their completely tubular peristomes directed towards the middle of the fenestra, being thus vertical and seen edgeways in frontal view. Frontal avicularia, absent on many zooecia, of moderate size, unilateral, mainly immersed, the rostrum broadly triangular and acute, slightly raised at its apex, directed obliquely outwards and proximally or distally, away from the middle line of the zooecium but usually towards that of the trabecula. Infrafenestral avicularia (fig. 1) common, vicarious, gigantic, spatulate, visible only in frontal view. They usually lie transversely across the proximal border of the fenestra; but the proximal end may be median, in which case the rostrum ascends one side of the fenestra. The palatel surface looks obliquely distally and frontally. Ovicell (fig. 2) often wider than long, crossed by oblique vibices, the labellum descending steeply, its carina well developed, the lateral slits partly concealed by the lateral flanges.

100. A, 36 mm. in greatest diameter, is a widely open, low cup (Pl. XXXV, fig. 7), of a pale purple or violet colour, spreading out at once from an oval basal plate 5 mm. in its longer diameter. It is not quite symmetrical, probably because one edge had met an obstacle which had interfered with its normal growth. Some of the fenestrae are almost slit-like, but the majority are more or less oval, slightly wider than the trabeculae. One of the marginal lobes confirms evidence, obtained from *I. willeyi*, that the gigantic infrafenestral avicularia are vicarious. The young avicularium in question possesses merely its basal and vertical calcareous walls; and it occurs as a unit of the colony, not as an appendage of another unit. It is situated in the axil of a growing fenestra, represented merely by its extreme proximal portion.

The basal surface (fig. 4) has conspicuous, separated rounded tubercles; the primary biserial kenozooecia not differing much from one another in size. Some of these pass across the entire width of a trabecula, so as to reach two or even three fenestrae; and most have one or two pores situated low down in the fenestra. Basal avicularia were not found.

The opercula (fig. 5) are short and wide, the proximal margin usually straight, the marginal sclerite indistinguishable. The frontal mandibles are wide in proportion to their length, acute. The large infrafenestral mandibles are long, wide throughout, rounded distally and asymmetrical; resembling those of *I. axillare*.

1) Mr Okada has informed me that both his figures represent specimens from Yodomi, Japan. It might have been inferred from his description that Pl. VIII, fig. 4 (see *I. axillare*) was from the Loochoo specimen.

Buchner based his var. *okada* on Okada's very brief indication of the characters of a specimen, from the Loochoo Is., which had been placed by him in *Retepora axillaris*. Buchner does not appear to have examined the specimen. Okada had stated that his colony (Loochoo Is.) was peculiar in the following respects; — its violet colour, its funnel-shaped, shortly stalked zoarium, its thin-walled peristome without marginal teeth or denticulations. These are the characters on which var. *okada* was based, and the Siboga specimen has them all.

Buchner was doubtless influenced by the fenestral avicularia in regarding this specimen as a variety of *Retepora axillaris*. On this ground alone it could be equally well placed in *I. sanguineum* and I think it is entitled to specific rank. I propose to name it after Buchner, in acknowledgment of the value and interest of his memoir on Reteporidae. Its unarmed secondary orifice is in striking contrast with the strongly denticulate orifice of *I. axillare*. The curious orientation of the peristomes of the proximal marginal zooecia of the fenestrae is another character of *I. buchneri*; and the opercula and frontal avicularia of the two species are notably different.

I. buchneri might be mistaken for *I. projectum*, with which it agrees in the general appearance of the pores and in the form of the secondary orifice, the denticulation of which may be difficult to find in both species. *I. projectum* does not have specially orientated fenestral zooecia, and I have not found fenestral avicularia, although a fair number of specimens of that species have been examined. The frontal avicularia of *I. buchneri*, moreover, are not related to the peristomes.

6. *Iodictyum axillare* (Ortmann). (Pl. XXXVII, figs 6—9).

Retepora axillaris Ortmann, 1889, JB, p. 36, Pl. II, fig. 25. Japan, 40 fath.
Retepora axillaris (pars) Okada, 1920, RAJ, p. 621, Pl. VIII, fig. 4 (zoarium); text-fig. 3 (ovicells). Japan, 63—312 fath.
Retepora axillaris Buchner, 1924, UJR, p. 197, Pl. XVI, figs 6—8. Japan.
? *Retepora axillaris*, var. *rustica* Buchner, ibid., p. 199. Japan, 250 M.

Cambridge, Mus. Zool.: —

BM. Japan, 20—40 fath. Owston Coll., 13.G. Reg. June 23, 1902. 1 small col.

Fenestrae widely oval (·9 × ·7 mm.) or circular, about as broad as the 3—6 serial trabeculae. Frontal shield (fig. 7) occupying a larger part of the area included by the septal ridges than in *I. buchneri*, the marginal valleys narrower. Pores usually 4, small, the proximal pair sometimes replaced by a median pore. Peristomial sinus very distinct, dilating proximally (fig. 7). Orifice with about 10 conspicuous denticles or ridges, equally spaced all round, in addition to the sinus-denticles; marginal teeth less distinct. Proximal fenestral zooecia not facing laterally as in *I. buchneri*. Gigantic infrafenestral avicularia (fig. 9) common and, as Ortmann stated, (partially) visible in basal view. The avicularium may lie across the fenestra, but in one instance it is median, directed distally and passing down the proximal border of the fenestra towards the basal side. The rare large frontal avicularia (fig. 8 and Buchner, Pl. XVI, fig. 6) are unilateral, the base sometimes extending across the middle line of the zooecium, considerably raised distally, the rostrum broad throughout. Basal surface with scattered, low, rounded tubercles and distinct but thin vibices, with the usual biserial kenozooecia, a few of which are conspicuously large. Their pores are on the margins of the fenestrae; and, as the colony is obviously young, the kenozooecia are probably primary. Basal avicularia not found.

Ovicells were absent, but OKADA found them in abundance. He described them as variable, but I have criticized this statement on pp. 522, 523. It is clear that they have the characters distinctive of *Iodictyum*.

The opercula (fig. 6) are longer than in most species. A marginal sclerite is present proximally and laterally, fading away distally. A fenestral mandible is figured, but I have not been able to isolate one of the rare frontal mandibles.

ORTMANN described this species as pale reddish. OKADA stated that it is always a dark purple in the living state, but changes to a lighter purple when dried, fading more or less in spirit. BUCHNER also mentions fading. The Cambridge specimen, which is without ovicells, was deeply cup-shaped, about 15 mm. high. Its colour was faintly pink or purple, but it had been in spirit and had probably faded. In all respects it conforms with ORTMANN'S diagnosis and with the later accounts.

I have seen no specimen which I can refer to var. *rustica* BUCHNER; which was described, without figures, as more robust in all parts than the typical form. Pores are stated to be larger and more numerous, usually 5. Frontal avicularia were not found, but the fenestral avicularia characteristic of *I. axillare* were exceptionally large.

7. *Iodictyum deliciosum* nom. nov. (Pl. XXXV, fig. 5; Pl. XXXVI, figs 25—28).

Retepora axillaris, var. *deliciosa* Buchner, 1924, UJR, p, 199, text-fig. R (operc., mand.). Japan.

Cambridge, Mus. Zool.: —

BM Type. Japan, 150 fath. OWSTON Coll., 44. A. Reg. June 23, 1902. 1 col.
Japan, 40 fath. OWSTON Coll., 5. AO. Reg. June 23, 1902. 1 col.

Zoarium (Pl. XXXV, fig. 5) rose-pink, saucer-shaped. Fenestrae elongate (about $1{\cdot}2 \times {\cdot}7$ mm.), oval or slit-like, about as wide as the 3—5 serial trabeculae. Septal ridges thick and very distinct, not quite so high as in *I. axillare*, the marginal valleys accordingly rather low. Pores conspicuous, usually 4. Peristome shortly tubular, at right angles to the surface, opening frontally, not completely immersed even at a much later stage. Orifice even, a small sinus hardly interrupting its circular outline; without marginal teeth except 2 short triangular lobes surmounting the sinus-denticles; a circlet of 10 equidistant denticles (in addition to the sinus-denticles) very distinct, shortly radiating inwards. Frontal avicularia on most of the zooecia, mainly immersed, unilateral, boat-shaped, the calcareous bar nearly at the middle, the rostrum directed proximally and usually slightly outwards, its short curved beak directed frontally. Fenestral avicularia not found. Ovicell subspherical, crossed frontally by the distal part of the peristome, which has become secondarily tubular; the labellum narrowly triangular, its carina moderate, bordered on either side by a long, narrow lateral sinus. Basal avicularia not found.

BUCHNER gave no figure of the calcareous parts of his var. *deliciosa*, which appears to deserve specific rank, and I adopt his varietal name for it. My figures of the opercula and mandibles (fig. 27) agree well with those shown by him on p. 200. He stated that the frontal avicularium, which is nearly constantly present, is always median and parallel to the long axis of the zooecium and that, "nach vorn", it develops a terminal calcareous process, in the curvature of which the closed mandible is received. The words "nach vorn" presumably refer to the

frontally directed beak, but I do not find that the avicularia are median. With a solitary exception, I find that the avicularium (fig. 26) is unilateral and is developed over the most distal pore of one side; a small pore commonly seen on its outer side probably belonging to the avicularium itself. The calcareous bar is so nearly at the middle that the orientation might easily be misunderstood, but the beaked end is constantly directed proximally.

Owing to its attractive pink colour, the regularity of the peristomial orifices with their equidistant denticles, the conspicuous pores and the nearly constantly present avicularia (fig. 26), this is an exceptionally beautiful species, a fact noticed by Buchner, who described the colony as "reizende". In correlation with the rarity of ovicells (in my specimens), practically all the peristomes seem to be "ordinary". In incinerated fragments the terminal walls split as readily as do the lateral walls (see p. 516). The peristomial sinus and the sinus-groove are very distinct, the sinus-denticles being slightly stronger than the others; and it is characteristic of this species that the sinus hardly interrupts the circular outline of the orifice.

My preparations show only three ovicells, and two of them (mature) have a distal (secondary) extension of the peristome across them. In the figured specimen (fig. 25) this part is incomplete, but it had probably been broken.

The central region of 44. A is completely covered frontally by distinctly outlined, scale-like kenozooecia, some small but mostly large and of no constant shape; each having 1 to 5 frontal pores. The zooecia and avicularia of this part have been completely occluded. The basal surface is at first smooth, later with sparse, rounded tubercles. The vibices are conspicuous, many of the kenozooecia being much longer than wide (fig. 28), their pores opening into the fenestrae at a deep level. Irregular kenozooecia, some very small, with one pore, cover the visible (old) part of the basal surface of 5. AO; their arrangement being different from that shown in fig. 28, which probably represents the primary set.

The opercula (fig. 27) are elongate oval, the marginal sclerite hardly indicated except at its proximal ends, the proximal margin gently convex. The mandibles are short, about as wide as long and rounded distally.

8. *Iodictyum spicatum* [1]) n. sp. (Pl. XXXV, fig. 8; Pl. XXXVII, figs 17, 18).

British Museum: —

Type. Torres Straits, 15—20 fath. A. C. Haddon Coll., 33. 11. 10. 1.

Zoarium (Pl. XXXV, fig. 8) pink-carmine, Reteporelliform, with no trace of fenestrae, producing short, robust branches at acute angles. Young zooecia limited by septal lines, without definite septal ridges or marginal valleys. Pores inconspicuous, probably 2—3 pairs. Peristomes large, very thick-walled, the marginal ones (or some of them) specially long, with everted lips produced into crenulations or marginal teeth; in the young state marked by several longitudinal lines; sinus distinct, wide, shallow, with 2 sinus-denticles, other denticles hardly present. A frontal avicularium at the proximal end of many of the zooecia is closely associated with the peristome of a preceding zooecium, running along its distal or lateral side; the rostrum long, narrow at its base, becoming acuminate, its apex usually projecting beyond the peristome as a

1) In allusion to the spike-like frontal avicularia.

free vertical spike. Fenestral and basal avicularia not found. Ovicell about as wide as long; the labellum descending steeply, specially long, its carina high, at least at the frontal end, the narrow lateral slits partially concealed by the lateral flanges, which lie deeply in the peristome.

The three fragments on which this account is based were found in a box containing unmounted material (90. 3. 24. 89) of *I. sanguineum* from Torres Straits. They show that *Iodictyum* may be completely Reteporelliform; since, although they are small, it is improbable that fenestrae would have been developed. The larger fragment (P. XXXV, fig. 8) is 13 mm. long, with a maximum width of 1·5 mm. just before a bifurcation, where there are 8—9 rows of zooecia. The peristomes are specially long and thick-walled; and some have about 8 strongly developed marginal teeth. Young peristomes show longitudinal lines running down their entire length (Pl. XXXVII, fig. 18). Each emargination of the orifice corresponds with the edges of shallow, outwardly projecting longitudinal folds of the peristome, the points of the marginal teeth being in line with the grooves between the folds. The longitudinal lines are due partly to these grooves and partly to a thickening of the wall visible through the semitransparent peristome. The frontal ends of similar ridges appear as internal denticles in certain other species. They actually form sinus-denticles in *I. spicatum*, but other denticles are hardly distinguishable. The number of pores has not been certainly ascertained, but is probably 4—6 (fig. 17). As in other species, a pair of specially large pores often occurs, in contact with the ovicell, on its distal side.

The frontal avicularia (fig. 18) are very characteristic, particularly when their free ends stand up as vertical spikes. In side view, the edges of the lateral walls of the rostrum are generally seen to be very convex; or, in other words, the apex of the avicularium is decurved. When viewed from the distal end, the two lateral ridges stand up above the apex, and the avicularium appears bifid.

The ovicells, of which many are present, are completely of the *Iodictyum* type. I have not been able to examine opercula and mandibles. The primary basal kenozooecia are large and are separated by weak vibices; but this surface is not favourable for examination. Secondary frontal kenozooecia, large and distinct, very slightly convex, and with 1—2 pores each, have invaded the central part of the colony, completely concealing the zooecia. They have spread round to the basal surface, where some remain distinct, but in other parts the vibices have become obscure; and this surface may appear completely uniform.

Section B.

Zoarium white or nearly so; pores small or evanescent; opercula thin, slightly chitinized, with indications of a submarginal sclerite; carina and lateral sinuses of ovicell asymmetrical.

9. *Iodictyum polycrenulatum* (Okada) (Pl. XXXV, fig. 11; Pl. XXXVI, fig. 5; Pl. XXXVII, figs. 23—27).

Retepora polycrenulata Okada, 1923, BSC, p. 225, Plate (no number), figs 7—9. Corea, 91—110 M.
Iodictyum (Retepora) polycrenulatum Harmer, 1933, GR, p. 625.

Group A. 459. O. Stat. 81. Borneo Bank, Strait of Makassar, 0—34 M. 1 young col.
Group B. 79. B. Stat. 105. Sulu Archipelago, 275 M. 1 col. (fragments).

Group C. 108. X. Stat. 144. S. of Halmaheira (Djilolo), 0—45 M. Fragments.
177. D. Stat. 257. Kei Is., 0—52 M.

British Museum: —

Japan, 46 fath. 32. 9. 10. 4.

Zoarium (Pl. XXXV, fig. 11) more or or less saucer-shaped. Fenestrae elongate (about 1 × ·5 mm.), usually wider than the 2—4 serial trabeculae. Septal ridges and marginal valleys variable, sometimes hardly existing. Frontal shields (young) often with three or four specially large and prominent tubercles; in older state, tuberculation often excessive. Pores usually 4, small, one pair at the extreme proximal end, the other near the middle of the zooecium. Peristomes short, the orifice circular, variably toothed, with strong marginal denticles. The sinus closes at once to form a conspicuous labial pore, generally situated on the proximal lip of the orifice. Avicularia (sometimes almost absent) commencing in the median line, the wide rostrum curving round the proximal margin of the peristomial orifice and even extending beyond it, sometimes bicuspid distally. Several infrafenestral avicularia, of moderate size and with acute mandibles, were found in one specimen (177. D). Primary ovicells thin-walled, globose, prominent, later entirely immersed by strongly tubercular outgrowths from the adjacent zooecia, and crossed by a secondary prolongation of the distal wall of the peristome.

In spite of certain discrepancies, the Siboga specimens may be referred to Okada's species with reasonable probability. He emphasized the entire absence of avicularia, but in some of my specimens they are very hard to find. He described the tubercles as small, and this is the case with some of the Siboga zooecia, which closely resemble his fig. 7. He appears not to have fully understood the structure of the ovicell.

The species (as I understand it) is characterized by its slender trabeculae, its elongate fenestrae, its conspicuous labial pore and its distinctive labial avicularia. The changes which result from increasing age are very marked; and old and young colonies might be supposed to belong to different species.

The largest specimen (177. D, Pl. XXXV, fig. 11) was irregularly saucer-shaped, with a maximum diameter of 24 mm. It has unfortunately deteriorated since its characters were first noted, by the disease which attacks the shells of Molluscs and the skeletons of calcareous Polyzoa. It was clearly young, the ovicells being globose and uncovered, and the frontal tuberculation resembled that figured by Okada. Avicularia were extremely rare, and I found only one or two of the normal labial type; the wide, short and acute mandible being represented in Pl. XXXVII, fig. 26. Decalcified preparations showed several relatively small fenestral avicularia, either 1 or 2 at the proximal end of a fenestra. In spite of careful search in the dry colony I discovered only one of these avicularia, forming a considerable projection into the fenestra; but I am unable to describe its characters. These avicularia have not been found in any other specimen. Basal tubercles were strongly developed.

459. O is a beautiful young colony of a very delicate appearance, its skeleton glassy and transparent, and only 7 mm. across. The central part, including the ancestrula (Pl. XXXVI, fig. 5) has been described above (p. 510). The fenestrae are large, all longer than wide, but variable in width. As the covering membrane has not been removed, the number of pores cannot be ascertained; nor is it certain whether the surface is tubercular. The younger peristomial

orifices (not shown in fig. 5), which open quite frontally, are very regularly circular, as in a Cyclostome; and the labial pore hardly interrupts the outline. They expand slightly to the actual orifices, some of which are distinctly everted. Marginal teeth are wanting, but marginal denticles are conspicuous, the typical number being 10; in remarkable agreement with *I. deliciosum* and *I. axillare*. As the original sinus has closed there are of course no sinus-denticles. The marginal peristomes project into the fenestrae, the most prominent part of their lip being a trifle prolonged, so that the orifice is shortly oval. Where an ovicell is developing at the growing margin, the deficiency of the distal wall of the corresponding peristome is very marked; the lateral parts ending abruptly in high, straight edges standing up from the zooecium. The characteristic labial avicularia are represented. The mature primary ovicell is small, very globose, thin-walled and glassy. The part of the peristome which crosses it begins to develop while it still has a frontal vacuity, as a prolongation of its lateral lobes; and in this colony it is still thin and inconspicuous. The basal surface has large, glassy tubercles.

108. X forms a striking contrast with 459. O. All parts of the frontal surface are thickly encrusted with a layer of large tubercles (Pl. XXXVII, fig. 23), which cover every part except the free edges of the immersed peristomes and the pores, which remain distinct. The ovicells (figs 23, 24) are hardly recognizable at first sight, nearly all trace of the primary thin-walled structure having been lost, except where a trabecula has been fractured so as to expose it. The labellum, with its associated parts, is visible, but it is situated deeply in the tuberculate peristome, and the distal margin of the peristome has grown across it as a pointed or rounded arch. Okada (fig. 8) figured what appears to be a median fissure in this position. Unless carefully studied, this fissure seems to be median and to be the only one. But the evidence is quite clear (fig. 23) that it is the larger of the two lateral sinuses, which are asymmetrical, as in other species of Sect. B; that the labellum is practically reduced to its prominent carina, in which a frontal pore is recognizable; and that the other lateral sinus is present, in its normal position, but reduced in size. The tuberculation of the basal surface (fig. 27) is excessive. The central region agrees in the main with that of 459. O. The completely immersed ancestrula, reduced to its peristomial orifice, can still be seen, though the colony is not very young; and it is surrounded by 6 equidistant zooecia. In most of these the edge of the orifice has probably lost some of its projections, but in several of the slightly younger zooecia marginal teeth are particularly strong. The two proximal ones stand up perpendicularly in such a way as to limit a deep vertical sinus or emargination of the peristome, nearly reaching the labial pore which was formed by the union of the sinus-denticles.

79. B is clearly a deep water specimen of this species. Its characters are typical, except that the labial avicularium (fig. 25) is bicuspid distally and is larger than usual. The fenestrae are also larger, nearly reaching 2 mm. in length. The trabeculae are mainly biserial, the tuberculation is slight and the peristomes are specially thick-walled. The ovicells are fully immersed and their asymmetry is shown by the conspicuous predominance of one of the lateral sinuses.

The Japanese specimen in the British Museum is a nearly flat, wavy colony. The denticles of the peristomial orifice are prominent, and a single labial avicularium was found.

The opercula (fig. 26) are delicate, with a submarginal sclerite which may be incomplete distally; their outline from almost semicircular to elongate. The fenestral mandibles are wide,

short, acute, curved (only found in 177. D). The labial mandibles, on the evidence of dry material, are much narrower at the base, curved horizontally like the rostra, diminishing gradually to the narrow distal end, the shape of the actual apex not having been ascertained.

10. *Iodictyum gibberosum* (Buchner) (Pl. XXXV, fig. 10; Pl. XXXVII, figs 28—33).

Retepora gibberosa Buchner, 1924, UJR, p. 201, Pl. XVI, figs 9, 10; text-fig. S, p. 202 (operc.). Japan, 120 M. or more.
Iodictyum (Retepora) gibberosum Harmer, 1933, GR, p. 625.

Group B. 67. M. Stat. 99. N. Ubian, Sulu Archipelago, 16—23 M. 1 young col.
479. A. Stat. 109. Sulu Archipelago, 13 M. 1 young col.

British Museum: —

China Sea, Macclesfield Bank. N⁰ 5, 27 fath. 89. 8. 21. 93; and same locality N⁰ 2, 26 fath., 33. 11. 10. 2. (originally mixed with *I. willeyi*, 89. 8. 21. 20).
China Sea, Tizard Bank, 27 fath. 89. 8. 21. 115.

Cambridge, Mus. Zool.: —

Torres Straits, Saibai Channel, 10—17 fath. HADDON Coll. 14, Reg. Feb. 24, 1898.

Zoarium (Pl. XXXV, fig. 10) more or less cup-shaped, small, delicate, glassy. Fenestrae oval, small (·8 × ·4 mm.), about equal in width to the 3—4 serial trabeculae. Zooecial and other characters agreeing with those of *I. polycrenulatum* except in the following respects. — Most parts, especially the zooecia, the peristomes and the orifices are smaller in *I. gibberosum* [1]). The frontal tubercles are much less numerous in the fully developed state. The pores are very small, reduced in number, frequently only one [2]), close to the proximal end and median, or 2 close together in a deep depression, in the same place. A pore may occur in the middle of the length of the zooecium, on one side. The labial pore is smaller and more definitely on the edge of the peristome, the margin of which may be toothed, but denticles are (in most zooecia) evanescent. The avicularia are frontal, not labial, rare or common, directed proximally or distally, sometimes obliquely. They are boat-shaped (Torres Straits, Pl. XXXVII, fig. 29), resembling those of *I. sanguineum*, or have a longer rounded mandible (Siboga) or may be acuminate (China Sea). In a single instance an enlarged frontal avicularium was found in an infrafenestral position (fig. 30). The asymmetry of the ovicell (figs 32, 33) is specially marked, and the ridge which secondarily encircles it is more developed than in *I. polycrenulatum*. The tubercles of the basal surface (fig. 31) are not so crowded. The basal vibices are strong and there may be long kenozooecia which reach two fenestrae. Basal avicularia have not been found. The opercula are wide and short.

The glassy consistency of the specimens has made the examination of details difficult; but incineration or cleaning with Eau de Javelle has been helpful.

BUCHNER described *I. gibberosum* as having ovicells differing from those of all other Retepores. They are in fact not essentially different from those of *I. polycrenulatum*; but, subject to the subjoined criticism, the ovicells I describe below agree with his account and correspond well with his fig. 9. Other points of agreement are the tuberculation of the zooecia, the common occurence of two proximal pores and the position of the labial pore, which BUCHNER figured

1) Note that figs 28, 30, 32, 33 are more highly magnified than the corresponding parts of *I. polycrenulatum*.
2) One, or perhaps 2, pores close to an avicularium probably belong to this structure and are not counted as zooecial pores.

but described as a sinus. Although he did not find avicularia they occur in my material; and in view of the great variability of their occurrence in many Retepores, I do not regard the difference as essential.

I have not obtained satisfactory preparations of the chitinous parts, but BUCHNER described and figured the operculum as nearly circular. He found well developed marginal denticles, which are generally evanescent in my specimens. It should be noted that his material was from deeper water than mine.

In the youngest state, when the septal ridges are distinct and prominent, the pores are generally at the extreme proximal end of the zooecium. Those of the mature zooecium are few and not easily seen; but, if only one were originally present, the development of an avicularium would probably occlude it, and no zooecial pore, as distinct from that of the avicularium, would then be discoverable. The single infrafenestral avicularium found (fig. 30) differs from similarly situated avicularia in species of *Iodictyum*, Sect. A, in not being vicarious; as it was clearly developed on the frontal side of a zooecium. The rostrum is wide distally, where it is bicuspid.

BUCHNER does not seem to have fully understood the structure of the ovicells. They possess a keeled labellum, as in other species of the genus; but the carina, in which there is a persistent frontal pore, is asymmetrical and very high (figs 32, 33), constituting the greater part of the labellum, which descends steeply into the peristome and is not always situated favourably for examination. The deep lateral sinus on one side of it is specially large, and its distal end is the median sinus of BUCHNER; but a second lateral sinus exists, on the other side of the labellum, and is shorter and less obvious. The lateral slits are deeply placed and are often concealed (as in other species) by the overhanging lateral flanges.

In its young state the ovicell is thin-walled and globose. The steep crater-like wall which later surrounds it is exactly as described by BUCHNER.

The only specimens in the Siboga Collection are two very young colonies, respectively 3 mm. and 2 mm. in diameter. The ovicells of the larger, 479. A (figs 32, 33), of which there are several, show that BUCHNER was right in stating that the ridge which crosses them is a derivative of the adjacent zooecia. Its proximal ends are connected with the peristome. One of the youngest peristomes is still sinuate, but the rest have a closed labial pore. In the central region the ancestrula is still visible. It was obviously surrounded by 6 equidistant zooecia; but of these one has been completely occluded by flat kenozooecia. In the ancestrula and in at least one or two of its derivatives definite marginal denticles are present, and these may occur in some of the still younger zooecia. The frontal avicularia (fig. 28) have an elongate mandible.

67. M, 2 mm. in diameter, agrees closely with the preceding specimen and has a few similar frontal avicularia. The ancestrula, represented by its unclosed orifice, is surrounded by 5 equidistant zooecia. A few of the more central zooecia have peristomes with strong marginal denticles, but the more peripheral peristomes have less prominent denticles, which would probably have been further reduced in younger zooecia, if these had been developed.

The Torres Straits material agrees with the others in the asymmetry of the ovicells and their encircling ridge, but differs in the shorter rostra of its avicularia (fig. 29).

Three specimens (China Sea) in the British Museum belong to this species. 89. 8. 21. 93 has typical ovicells in profusion. The frontal avicularia, not common, differ from those of other

localities by being acute, the mandible acuminate. The zoarium of 33. 11. 10. 2, with the same characters, had much waved lobes, seldom anastomosing. In 89. 8. 21. 115 the avicularia are very rare, but at least one acute one was found.

11. *Iodictyum perarmatum* [1]) n. sp.

(Pl. XXXV, fig. 9; Pl. XXXVII, figs 19—22; text-fig. 29).

Group C. 111. E. (Type) and 112. H. Stat. 156. W. of Waigeu Id., 469 M. Several flat pieces.

Zoarium (Pl. XXXV, fig. 9) probably saucer-shaped, branches flat. Fenestrae large (2 × 1 mm.), longer than wide, fairly uniform in size, wider than the 2—4 serial trabeculae. Septal ridges low, enclosing specially long, relatively narrow areas, which later become elongate zooecia. Frontal shield moderately convex, practically filling the area, so that marginal valleys are narrow or hardly distinguishable. Pores very small, seldom more than 2 proximal and 1 unilateral and more distal; the reduced number possibly correlated with the abundance of avicularia (cf. p. 560). Peristomes at first short and cylindrical, rising at an angle of about 90° and thus opening frontally; the orifice later much expanded, exceptionally prominent, with very strong and variable marginal teeth and denticles. Labial pore small, on the edge of the secondary orifice. Large triangular, acute avicularia and small oval ones may occur frontally; in addition to gigantic, wide infrafenestral avicularia. The acute frontal avicularia of marginal zooecia sometimes project laterally into the fenestrae. Primary ovicells globose, wider than long, the carina of the labellum high, the lateral sinuses very asymmetrical; later crossed by a crater-like ridge, as in *I. gibberosum*. Basal surface with very large acute avicularia and numerous small ones.

This beautiful species, one of the most remarkable dredged by the Siboga, is clearly allied to the two preceding, with which it agrees in the structure of the ovicell and in other characters. It differs from them in the excessive development of the marginal teeth and denticles of the peristomes and of the crater-ridge of the ovicells, in the larger size of all its parts and in the profusion of the avicularia of three kinds.

In young zooecia at the growing margin, the labial pore is continued as a labial tube which projects as a longitudinal ridge on the outer side of the peristome; ceasing to be visible at a later stage. The peristome now becomes greatly expanded towards its orifice, which is exceptionally strongly toothed (Pl. XXXVII; figs 20, 22), varying in details but generally more or less bilabiate, with lips which may be at least as long as the height of the tubular part. The marginal teeth are greatly thickened on their inner sides, producing strong longitudinal ridges which give rise to about 10 conspicuous denticles. The lips are often bifid or may have one or two lateral cusps, each ridged like the main lobe and, like it, producing a denticle. The marginal peristomes project into the fenestrae and are visible in basal view (fig. 21), as well as frontally. They remain conspicuous even in moderately old branches. When secondary calcification invades the frontal surface, the peristomial lobes, possibly reduced by breakage, frequently remain as irregular projections. The frontal kenozooecia responsible for these changes sometimes form a large projecting mass, subdivided by strong vibices like those of the older parts of the basal surface. In one instance the half open mandible of a gigantic infrafenestral avicularium has

1) In allusion to the very numerous avicularia of three kinds, on both surfaces of the colony.

been separately invested in a calcareous covering and forms a projecting prominence retaining the shape of the mandible.

The frontal avicularia (fig. 22) are specially numerous and of three kinds; — (*a*) small, oval, boat-shaped, slightly but equally raised all round, the rostrum rather longer than the proximal part; a large majority directed distally or obliquely so; two or three of these avicularia sometimes occurring on one zooecium; (*b*) larger, acute, the apex often much raised and projecting freely; the rostrum long and widely triangular, the orientation typically obliquely proximal; in parts of the colony descending into the lateral margins of the fenestrae; (*c*) infrafenestral, vicarious, longitudinal (fig. 20), directed distally, specially gigantic, replacing a distal zooecium of a trabecula and occupying a considerable part of the frontal surface; much raised proximally and descending into the fenestra, the rostrum very wide and long, rather wider distally.

In certain parts of the colony the large acute avicularia are common on the frontal surface, but no basal avicularia of the same kind occur; or *vice versâ*. Elsewhere they may be completely wanting. The acute avicularia of marginal zooecia are often shifted into the lateral parts of the fenestrae, passing to the basal sides of the preceding peristomes and being thus most easily seen from the basal side. An actual fenestra, shown in text-fig. 29, is bounded on each side by 4 zooecia, seven of which bear avicularia. R. 4 and L. 4 are frontal avicularia with normal position and orientation, directed obliquely towards one another, each associated (as usual) with the preceding peristome; and R. 1 is also a normal frontal avicularium. The rostrum of R. 2 is entirely visible, but it is directed obliquely downward into the fenestra. Those of R. 3, L. 1 and L. 2 lie mainly on the basal side of the peristome; and the zooecium L. 3 alone has no avicularium. Other fenestrae give the same evidence, with the addition that some of the migrated avicularia are no longer visible in frontal view and completely face the fenestra, so that when viewed from the basal side they are seen edgeways, being directed longitudinally along the fenestra.

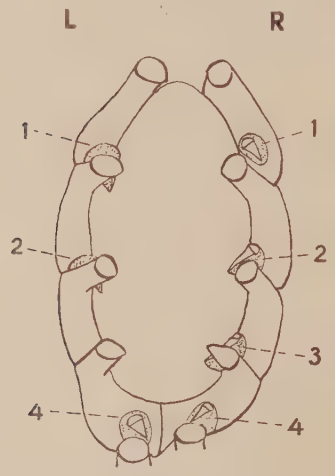

Fig. 29. *Iodictyum perarmatum* III.E¹. Fenestra and marginal zooecia, to illustrate the alterations in position by which frontal avicularia become fenestral avicularia. For explanation, see text.

The normally situated frontal and the lateral fenestral avicularia are mutually exclusive and do not occur on the same zooecium. I have not found basal acute avicularia in any place where frontal avicularia, whether actually frontal or fenestral, are present; but it cannot be supposed that avicularia on basal kenozooecia are displaced frontal avicularia. Whether situated frontally or basally, the avicularia are developed near the growing margin; in the one case from zooecia and in the other from primary kenozooecia. They are clearly different morphologically from the vicarious infrafenestral avicularia (fig. 20).

The primary ovicells (fig. 22) are thin-walled, globose and wider than long. The carina of the labellum is conspicuously high, often with a persisting frontal pore; and one lateral sinus is definitely larger than the other. The fertile peristome has a massive, pointed and vertical triangular process, almost a spike, distally on each side. A specially high crater-wall, similar to that of *I. gibberosum* but longer than wide, is developed later and is produced into strong lobes, of varying form but in general like those of the peristomes. These, with the two spikes of the

peristome, indicate clearly the position of the immersed ovicell when it is buried in a secondary calcareous covering, a process which occurs in substantially the same way as in the other species. The larger lateral sinus is now very obvious and it would certainly have been mistaken for a median structure if young ovicells had not been examined.

The basal surface is at first smooth or finely granular, the vibices not prominent and very inconspicuous. In the older state it may bear numerous low tubercles and a few scattered, large and conical tubercles; the latter, in some instances at least, being the remains of the large acute avicularia buried in a calcareous crust. Small secondary kenozooecia in process of development are visible, overlying a large kenozooecium, their edges partly coinciding with portions of the primary vibices. The original pattern may perhaps in some cases remain little altered by these changes and it is questionable whether primary and secondary kenozooecia are always distinguishable. Some of the smaller kenozooecia in fig. 21 are secondary, and the figure shows that a large kenozooecium may reach two or three fenestrae. The vibices are strong and very prominent in some of the old branches.

Numerous small oval avicularia, like the frontal ones, occur basally; and there may be at least three on a large kenozooecium. A depression which looks like an ordinary pore is sometimes the result of the partial burial of an avicularium, a process described by BUCHNER (1904, UJR, p. 176 et seq.) in other species. The acute basal avicularia, directed proximally, with some obliquity, are much raised and very conspicuous. They are generally larger than the corresponding frontal avicularia and the extent to which the apex projects freely is greater.

The opercula (fig. 19, *a*, *b*) are delicate and small, hardly larger than the mandibles of the oval avicularia (*c*). Their proximal margin is generally straight, but is occasionally convex, and there is a submarginal sclerite, often incomplete distally. The large frontal (*e*, *f*), lateral fenestral and basal mandibles are acute and widely triangular (*f*) or rarely (*e*) slightly obtuse. The exceptionally large infrafenestral mandibles (*d*) are broad and long, widening distally, where they are asymmetrical.

2. **Malleatia** Jullien.

Malleatia Jullien, in JULLIEN and CALVET, 1903, BCH, pp. 57, 106.
Malleatia Canu and Bassler, 1929, BPR, p. 337.
Malleatia Calvet, 1931, BCAM, p. 101.
Malleatia Harmer, 1933, GR, p. 621.

Genotype, indicated by JULLIEN, *Malleatia rara* Jullien, 1903, p. 106, Pl. XIV, figs 1*a*, 1*b*.

Fenestrate. Peristomial orifice connected by a short suture with a labial pore (CALVET, 1931). Primary ovicells globose, the frontal wall with a median fissure as in *Sertella*, the labellum distinct, not carinate. These parts remain exposed in the genotype, the ovicell not being at first completely covered by secondary overgrowths of the adjacent zooecia. Avicularia all small, oval or pointed, found on both surfaces, on which the tubercles are connected by low ridges giving rise to a honeycomb-like pattern.

This genus was introduced by JULLIEN with an insufficient diagnosis, the most important characters being the ornamentation of both surfaces by cupuliform punctuations as if hammered,

and the occurrence of a lyrula in the peristome. He did not find ovicells. CANU and BASSLER merely paraphrased the original diagnosis.

A more detailed description of *M. rara* was given in the posthumous memoir of CALVET (1931, BCAM, p. 100, Pl. II, figs 12—15*c*), who introduced three new varieties, all from deep water, 394—1385 M. from between Norway and Bear Id. to the Azores. CALVET stated that the lyrula described by JULLIEN does not exist; — a conclusion which appears questionable in view of the common if not universal occurrence of this structure in Reteporidae. In other respects he confirmed the original account. His most important addition was a description of the ovicells, which have a median frontal fissure, remaining exposed when the primary ovicell has been largely covered by secondary calcification, but being completely occluded later. The opercula, which were figured (15*a*—*c*), are more or less semicircular, as wide as long or considerably wider. *Retepora rara*, var. *granulosa* (Azores), one of the new varieties or "forms" from the Azores, was said to differ from *R. rara*, var. *typica* (Azores) and *R. rara*, var. *septentrionaria* (N. of Norway) in not having the "hammered" punctuations of the surface.

Although CALVET in 1931 rejected *Malleatia*, for which he had been partly responsible in his joint memoir with JULLIEN (1903), I think it may prove to deserve recognition, perhaps as an abyssal genus. A species which I describe below as *Sertella cyclostoma* has a remarkable resemblance to *M. rara* in its surface-ornamentation. It is represented merely by minute fragments in poor condition. They are insufficient for the establishment of characters by which *Malleatia* can be distinguished from *Sertella*, and I do not therefore refer them to the former genus, although I think that may well be their position.

3. **Sertella** Jullien.

Sertella Jullien, in JULLIEN and CALVET, 1903, BCH, pp. 56, 57.
Ellipsia Jullien, ibid., p. 56.
Sertella and *Ellipsia* Harmer, 1933, GR, p. 620.
Retepora (pars) auctt.

Zoarium reticulate. Ovicell with a narrow median fissure, sometimes extending along the entire frontal surface and often situated partly in the labellum; or shorter, rarely closed in the older ovicells. Primary orifice and operculum wider than long. Genotype, *Sertella beaniana* (King).

Sertella was introduced by JULLIEN for 6 species, including *Retepora beaniana* King, but without indication of a genotype. The genus was defined as having transversely oval primary orifices, finely denticulate laterally and distally. I am not sure that a denticulate orifice always occurs, and in any case it is not distinctive since it is found in species belonging to other genera (cf. Pl. XXXVIII, figs 14, 27). In 1920 Canu and Bassler (ETB, p. 501) selected *Retepora beaniana* as the genotype. This common and well known species was originally described by King (1846, AMNH, XVIII, p. 237), but a more satisfactory account was given by Hincks in 1880 (BMP, p. 391, Pl. LIII, figs 1—5).

I have previously (1933, GR, p. 618) given my reasons for not accepting *Retepora* in a restricted sense as the generic name of the numerous species of reticulate Retepores in which the ovicell has a median frontal fissure. This may close in the mature condition, as in *Sertella carinata* (*Retepora carinata*, MacGillivray, 1884, PRSV, XX, p. 110), in which a median keel

results, running along the greater part of the frontal surface and not confined to the labellum, as is the case in *Iodictyum*. In the majority of species, however, the fissure remains permanently open. So far as I have been able to observe, the labellum of most of the species is not much developed, being sometimes represented merely by a slight convexity of the free frontal margin. In other species, as in *S. granulata* (p. 566), it is moderately long.

Key to the species of *Sertella* here recorded.

1	A honeycomb-like surface-ornamentation frontally and basally. Fertile peristomes shortly tubular, the orifice circular and Cyclostome-like . . .	1. *S. cyclostoma.*
	Ornamentation not honeycomb-like	2
2	Fissure of ovicell relatively short and wide, almost confined to the labellum and often concealed by the strongly tubercular calcification which covers nearly all parts of the colony	2. *S. granulata.*
	Fissure long, narrow, extending along nearly the whole frontal surface. Tuberculation not excessive	3
3	Peristome slightly raised. Labial suture long, equalling the diameter of the peristome. Labial avicularia wanting	3. *S. longifissa.*
	Peristome not raised. Labial suture shorter. A minute circular labial avicularium or a larger munitiform avicularium near the peristomial orifice	4. *S. suluensis.*

1. *Sertella cyclostoma* [1]) n. sp. (Pl. XXXVIII, figs 1—3).

Group B. Type 79. F. Stat. 105. Sulu Archipelago, 275 M. Fragment.

Zoarium small. Fenestrae much longer than wide, up to 2.5 mm. long, wider than the delicate 2—3 serial trabeculae. Frontal surface entirely covered by tubercles connected by ridges in such a way as to give rise to a conspicuous honeycomb-like arrangement (Pl. XXXVIII, fig. 2). Zooecia (old) to some extent limited by septal lines, but partly covered by kenozooecia outlined by vibices which do not correspond with those lines. An occasional large tubercle (fig. 3) occurs frontally but is frequently incompletely calcified so that it appears as a short, open, cylindrical tube. Pores found only on the kenozooecia. Ordinary peristomes short, vertical, the orifice almost completely circular, the outline hardly interrupted by the sinus, which is bordered by two distinct sinus-denticles generally uniting at a slightly deeper level to form a closed labial tube; occasionally remaining unclosed. About 6—9 additional marginal denticles, distally and laterally. A single fertile zooecium has a strongly beaked labial avicularium inside the peristome; the overgrowth of the ovicell by secondary calcification having been very irregular. Frontal avicularia principally at the proximal end of a fenestra, less often at the distal end, immersed, rather long, triangular, with no constant orientation. Primary ovicell large, wider than the peristome, becoming completely immersed and surmounted by a tubular peristome (fig. 3, middle zooecium); its orifice without a sinus, small, circular or transversely oval. Basal surface with a honeycomb-like ornamentation like that of the other surface; with conspicuous interspersed conical tubercles and few, irregular vibices.

1) Referring specially to the Cyclostome-like fertile orifices.

The only specimen is a very small fragment, its appearance greatly altered by secondary calcification. Growth seems to have ceased at the tips of the trabeculae, one or two of which end in a terminal, projecting, median zooecium. This is outlined by distinct septal lines, but there are no marginal valleys.

The examination of the ovicells has been very difficult, in consequence of their complete immersion and of the nearly vertical position of the labellum. The primary ovicell is typically globose, as shown by its exposure in a broken trabecula, where it is short and wider than long. Only one ovicell shows the later characters satisfactorily, although incompletely. The fertile peristome (fig. 3) is small, tubular and transversely oval, without denticles or a visible sinus. The labellum, which descends almost vertically, is triangular, becoming very narrow basally. As it has no carina, lateral sinuses do not exist, but there are well marked, oblique lateral slits. It is not always possible to decide that a zooecium is a fertile one, since the ovicell is generally invisible, concealed by secondary calcification. I believe however that the shortly tubular peristomes with a completely circular or oval non-sinuate orifice are of this nature. They seem to be usually median members of a triserial trabecula.

On p. 564 I have indicated my opinion that this species should perhaps be placed in *Malleatia*. It is obvious, however, that the characters which I have based on very fragmentary material will need confirmation and extension when better specimens become available.

2. *Sertella granulata* (MacGill.) (Pl. XXXV, fig. 16; Pl. XXXVIII, figs 4—6; text-fig. 30).

Retepora granulata MacGillivray, 1869, PRSV, IX, p. 140; 1883, ibid., XIX, p. 290, Pl. II, fig. 7; 1884, ibid., XX, p. 112, Pl. II, fig. 11 (operc.. mand.); 1885, PZV, Dec. X, p. 29, Pl. XCIX, figs 1—3 (fig. 1, zoarium); 1895, MTPV, p. 117 (Tertiary). Victoria.
Retepora granulata Hincks, 1878, GR, p. 363, Pl. XIX, figs. 13—15. S. Australia.
Retepora granulata Marcus, 1923, BAI, p. 433. Aru Is., 10 M.
Retepora granulata Canu and Bassler, 1929, BPR, p. 370 (no description), Pl. XLVIII, figs 6—8. Philippine Is., 240 fath.; Borneo, 175 fath.
Retepora carinata Kirkpatrick (nec MacGill.), 1890, TS, p. 612 (no description). Torres Straits, 15—20 fath.
? *Retepora carinata* Meissner, 1902, ATIB, p. 731 (no description), Thursday Id. (Torres Straits).

Group A. 33. A. Stat. 65a. Tanah Djampeah, between Flores and Celebes, 120—490 M.
Group B. 471. B. Stat. 98. Sulu Archipelago, 350 M.
Group C. 108. D. Stat. 144. S. of Halmaheira (Djilolo), 0—45 M.

Cambridge, Mus. Zool.: —

Victoria, HINCKS Coll., Reg. May 13, 1899.
Victoria, Miss E. C. JELLY, Reg. May 24, 1895.
Torres Straits, HADDON Coll. 20. Reg. Feb. 24, 1898 and May 26, 1900 (determined by KIRKPATRICK as *R. carinata*).

Zoarium (Victoria) typically large, massive, convolute, with small oval fenestrae, narrower than the trabeculae; in the Siboga Collection cup-shaped, occasionally (Pl. XXXV, fig. 16) with delicate trabeculae and large fenestrae. Trabeculae (Siboga) usually 3—7 serial. Young zooecia shortly hexagonal, with prominent septal ridges and deep marginal valleys, generally with two pairs of pores. Frontal surface with an excessive amount of tuberculation, even at the growing margins. Primary orifice wider than long, with 2 lateral condyles, its distal margin finely denticulate.

A pair of short lateral spines, or 3 (1 median and distal) in young zooecia, but not commonly. Labial pore [1]) connected with the edge of the peristome by a short labial suture. Labial avicularium usually small, nearly circular, its short rostrum sometimes finely denticulate; or larger, often conspicuously beaked. Frontal avicularia small, oval, generally present; or larger and acute, directed proximally. Primary ovicells early obscured by tubercular calcification, leaving merely the descending part of the frontal surface uncovered, though often concealed in frontal view. The tuberculation frequently extends, on the ovicells and lateral margins of the orifices, into the peristome (Pl. XXXVIII, fig. 4). Labellum broad, with a wide and short longitudinal fissure, flanked by lateral slits; lateral flanges not recognized.

Basal surface at all stages with inconspicuous vibices, as indicated by Canu and Bassler (1929, Pl. XLVIII, fig. 8), sunk between the slightly convex kenozooecia; the surface generally with large tubercles like those of the front; or finely granular, sometimes with large interspersed tubercles. Kenozooecia (text-fig. 30, B) commonly with several pores, some of which are avicularia in process of occlusion. Avicularia small, round, fairly numerous, like those of the front.

Opercula (text-fig. 30, C, E, G. wider than long, with a marginal sclerite distally and laterally. Mandibles of small round avicularia (E) sometimes minutely denticulate, those of the longer labial avicularia with a strongly decurved acute tip. The large frontal mandibles (F) are triangular, acute, less decurved terminally.

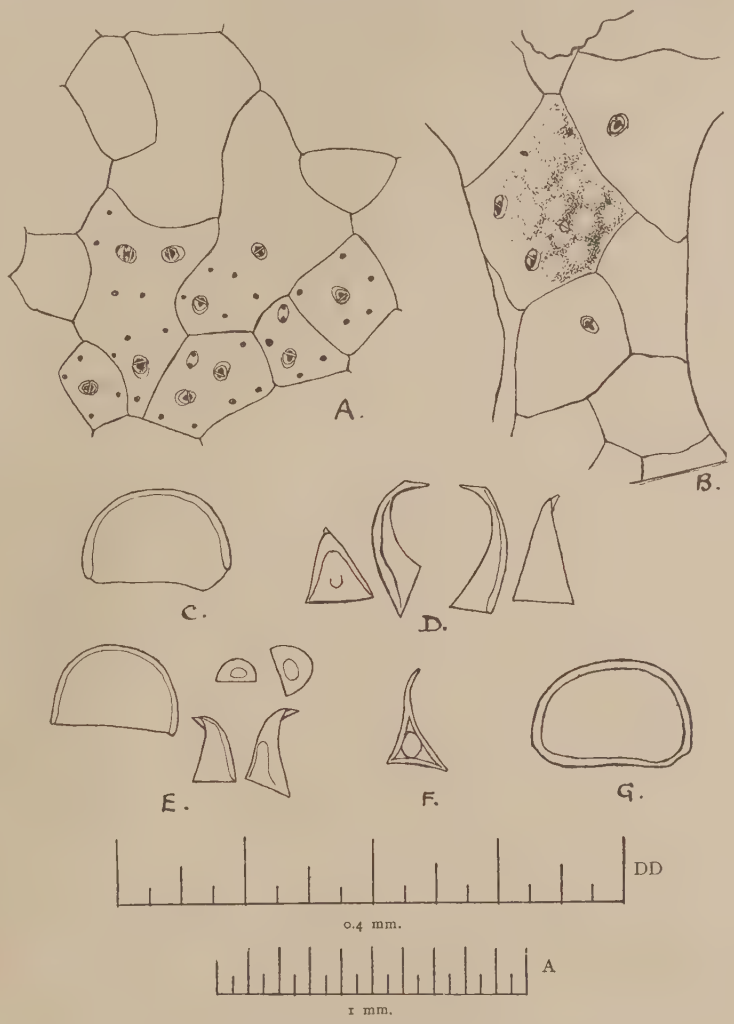

Fig. 30. *Sertella granulata*. A, 33. A². Central frontal kenozooecia and avicularia. Obj. A. — B, same slide. Basal kenozooecia and avicularia. Obj. A. — C, 108. D². Operculum. Obj. DD. — D, same slide. Mandibles. Obj. DD. — E, 33. A³. Operculum and mandibles. Obj. DD. — F, Mus. Cambridge, Torres Straits, 20. Mandible. Obj. DD. — G, ibid., Victoria, Hincks Coll. Operculum. Obj. DD.

The peristomial orifices at first face distally, being partially concealed by a projecting proximal lip. As in other species, they become completely immersed later, the orifices being then more or less transversely oval. The tuberculation of the frontal surface is variable, but is

1) Canu and Bassler's fig. 7 suggests a sinuate condition of the peristomes, but it does not well represent the characters of this striking species.

always present and it constitutes a distinctive feature of the species. As stated by MacGillivray (1869), the tubercles are prominent enough to appear as a crenulation of the margins of the fenestrae. The labial avicularia are commonly small and so situated that their oblique palatal surface is visible in frontal view (Pl. XXXVIII, fig. 5). In the Torres Straits material the labial pore is at one corner of the peristome and the large avicularium may lie vertically (thus seen edgeways) along the entire proximal margin, its palatal surface facing distally, the strong curved beak occupying the corner opposite to that of the sinus. Near the growing margin, this kind of avicularium forms a conspicuous swelling covering much of the frontal surface and adding to its natural convexity. A small oval frontal avicularium (rarely 2), directed proximally, occurs on most of the young zooecia. It is sometimes replaced by a larger immersed, triangular avicularium, as in the Torres Straits material. In Victorian specimens, as described by MacGillivray (1883), these form conspicuous swellings of infrequent occurrence. In 108. D (Siboga) many of the zooecia have a large acute avicularium (Pl. XXXVIII, fig. 4), with proximal orientation, the apex projecting at the top of the mound-like swelling. This specimen (Pl. XXXV, fig. 16) is remarkable for its slender trabeculae, much narrower than the elongate fenestrae, which may be as large as $2{\cdot}5 \times 1$ mm.; in contrast with the massive character of Victorian specimens, which it resembles in other essential respects. Frontal kenozooecia (text-fig. 30, A) may produce a larger number of avicularia; 2 or 3 small oval on each, or a larger acute avicularium with inconstant orientation.

The ovicell has not been correctly understood by earlier observers. MacGillivray (1883) stated that it is fissured when young, the slit becoming filled in as calcification advances; and Marcus also says that the slit disappears. I find that the fissure not merely persists invariably, but that it remains wide and distinct (Pl. XXXVIII, fig. 4). In Victorian material the ovicell is much overgrown by the tubercular crust, and the labellum with its wide slit becomes concealed in the peristome, although it is visible if the specimen is suitable inclined. In 108. D (fig. 4) the tuberculation is less developed and the slit is exposed in frontal view; 33. A being intermediate between these two conditions. In the Torres Straits specimens a greater part of the primary ovicell remains uncovered, and the slit is easily seen.

The following account, illustrating growth-changes, refers to 33. A, in which the young zooecia (Pl. XXXVIII, fig. 6) have a thin, smooth, convex wall. This develops, almost at once, about 9 prominent, hemispherical tubercles, which cover the whole surface except the frontal avicularium; the septal lines which bound the shortly hexagonal zooecia remaining distinct. The primary ovicell becomes covered by parts of the adjacent zooecia, as in other species; and it commonly bears an avicularium, which is the frontal avicularium of its distal successor. In a somewhat older condition (fig. 5) every peristomial orifice is connected with its four alternate neighbours by short and straight septal lines, at right angles to one another, a condition not infrequent in Retepores and shown by Waters (1909, SRS, Pl. XVIII, fig. 9, as *Retepora abyssinica*), in *Reteporellina abyssinica* (see p. 585). The number of frontal avicularia has increased, each area commonly having 2. This occurs in many zooecia in which the septal lines persist; but in other instances kenozooecia have been superposed, their vibices not differing from the septal lines except by their inconstant arrangement. Some of the kenozooecia occlude the peristomial orifices, and each may have 1 or 2 avicularia. As has been pointed out above (p. 515) avicularia

produced by frontal kenozooecia are inconstant in their orientation. The central part of this colony is completely occluded by distinct, large, frontal kenozooecia (text-fig. 30, A), varying in form, each with 1 or 2 small, round avicularia and a moderate number of submarginal pores.

3. *Sertella longifissa* [1]) n. sp. (Pl. XXXV, fig. 18; Pl. XXXVIII, figs 7—9).

Group C. Type 111. C. Stat. 156. W. of Waigeu Id., 469 M. Fragments.

Zoarium (Pl. XXXV, fig. 18) fenestrate; the 2—4 serial, robust, convex trabeculae subparallel, limiting very large, elongate fenestrae, as much as 5 × 2 mm. Youngest branch triserial terminally, with a projecting median zooecium. Septal ridges distinct, low; marginal valleys wide, shallow. containing about 4—6 or more minute, submarginal pores on each side. Zooecia large, at first convex, diminishing regularly to the shortly cylindrical, thick-walled peristome, which projects but slightly, even in marginal zooecia. Median zooecia (of a triserial trabecula without ovicells) flat, wide, hexagonal. Frontal surface entirely covered by close-set, minute tubercles. Older peristomes (Pl. XXXVIII, fig. 8) slightly raised proximally and laterally; later immersed, the orifice subcircular, or transversely oval, the thin-walled edge plain, without teeth or denticles. Labial pore connected with the orifice by a long labial suture; labial avicularia apparently wanting. A pair of spine-bases, on either side of the distal edge of the orifice, found in one marginal zooecium. Frontal avicularia numerous, small, immersed, as many as 5 on a zooecium, occurring in the lines of the marginal pores or nearer the middle, and of two kinds; — (1) minute, subcircular but usually wider than long, the calcareous bar practically at the middle, the rostrum projecting vertically; (2) rather wider, the rostrum longer than the proximal part, horizontal, with projecting edge; — the orientation of both kinds inconstant.

Ovicells (fig. 7) large, conspicuous, widening and most raised distally, longer than wide; a very narrow longitudinal fissure extending along almost the entire length, its distal end being the most elevated part of the ovicell. Labellum wide at its base, subtriangular with convex free margin, sufficiently long to give rise to lateral slits; the lateral flanges narrow. The ovicells are covered, apparently from a very early stage, by the tuberculation of the general surface, but not to the extent of rendering them inconspicuous.

Basal surface with tuberculation as on the front, the primary kenozooecia biserial with weak vibices, the older ones with stronger vibices and a few small avicularia like those of the front. A single larger avicularium like that of *S. suluensis* (Pl. XXXVIII, fig. 12) was found basally, near a fenestra.

In calcined fragments the septal lines and the vibices have split along their entire length, implying that each of these lines has an organic median lamella. This is a species in which kenozooecia have been superposed on one another without altering the pattern of the vibices (see p. 517). The thick basal wall is composed of a succession of laminae (fig. 9), of which as many as 10 can be counted in another part. In other portions a single vertical vibex has extended through the entire series of laminae, the free edges of which may not exactly coincide, however, with those of their immediate predecessors.

Owing to the small amount of material I have been unable to isolate mandibles and opercula

1) In allusion to the long fissure of the ovicell.

The surface of this specimen has been altered by the development of superficial calcareous tubes on the frontal surface. These were possibly induced by the presence of a Hydroid, but apparently not of the species commonly found on *Triphyllozoon*.

4. *Sertella suluensis* n. sp. (Pl. XXXV, fig. 17; Pl. XXXVIII, fig. 10—12).

Group B. Type 83. A. Stat. 105. Sulu Archipelago, 275 M. 1 small piece,

British Museum: —

Misaki, Japan 590—600 fath. 21. 11. 7. 12. i. (probably this species).
Same locality. 21. 11. 7. 12. ii. (probably a young specimen of the same species).

Zoarium (Pl. XXXV, fig. 17) fenestrate, rather more delicate than that of *S. longifissa*, the fenestrae not quite so large, much longer than wide, some slit-like; trabeculae convex, more or less parallel, 2—4 serial. Youngest branch ending in a projecting median zooecium, with inconspicuous septal lines and no marginal valleys. Zooecia smaller than in the preceding species, the tubercles not quite so distinct. Peristomes thick-walled, at no stage prominent, their orifice transversely oval, connected with a labial pore by a short suture, on one side of which there may be a minute, circular labial avicularium or a much larger munitiform avicularium. Small frontal avicularia, of two kinds as in *S. longifissa*, numerous. Ovicells large, traversed by a long, narrow, median fissure which may close, giving rise to a suture sometimes slightly keeled; labellum descending very steeply. Basal surface with numerous small tubercles, many small avicularia, some forming mound-like projections, and occasional large avicularia widening distally. The vibices, in young parts, are very weak and inconspicuous; but some, specially those which cross the trabeculae transversely, are prominent and ridge-like.

The anastomoses of the zoarium are sometimes formed by barren trabeculae. The peristomes early become immersed, so as to appear as depressions not outlined by a prominent lip. The minute labial avicularium, if present, generally lies in a depressed area leading from the peristome to the labial pore (Pl. XXXVIII, fig. 10, middle zooecium) If a munitiform avicularium occurs there is no such area (R. and L. zooecia). This kind of avicularium appears in the young state as a conspicuous mammilla, by which the labial pore is shifted to one side and is sometimes discoverable with difficulty. Its projection becomes reduced by secondary calcification, but it continues to occupy a considerable part of the frontal surface. Its palatal region is a transversely elongate slit, inside which is a strong brown mandible of the typical munitiform character, at least twice as wide as long and with a projecting flange round its distal and lateral margins (Pl. XXXVIII, fig. 11). The small frontal avicularia are immersed, or form conical eminences to which the irregularity of the surface is largely due. 4 such avicularia may occur on a zooecium, and they may also be found on an ovicell or even on a munitiform avicularium (fig. 10).

In one part of the colony, near its growing tips, an island of small frontal kenozooecia has appeared, occluding at least one orifice; and nearly all of them have each one small avicularium of the elongate type. Rare avicularia widening distally (fig. 12) may be found on the frontal surface.

The ovicells (fig. 10) are conspicuous, the distal end usually raised and projecting. They vary in form but are generally pyriform, wider distally, though they are sometimes most inflated at the middle or even proximally. The frontal surface is often nearly flat. If the long median

fissure closes, its distal end, which is the most prominent part of the ovicell, remains as an open pore, the limiting wall being more or less spout-like and slightly projecting. These characters give the ovicell the appearance of a bilaterally symmetrical rather than of a globose structure. The ovicell is sometimes longer and narrower than those figured, and one or two resemble the specially long ovicells of *Sertella gracilis* figured by Jullien (1903, BCH, Pl. VI, fig. 5*a*) from deep water off the Azores. The distinct labellum is bordered by lateral slits, but the descent of this part is so steep that it is seen with difficulty, and the labellum might be supposed to be absent.

The British Museum Collection includes two specimens from Japan which may belong to this species. The first (21. 11. 7. 12. i) resembles 83 A in its robust appearance, its large fenestrae and the general characters of its frontal surface, of its peristome and of its labial avicularium, pore and suture. It differs from it in the rarity of frontal avicularia, although a few of the more elongate small kind are present, and in the absence of avicularia definitely munitiform. These appear to be represented, however, by a frontal avicularium, not larger than the ordinary small ones of this surface, found on certain zooecia, at some distance from the peristome. The mandible agrees with the munitiform type in being considerably wider than long, but it is thin and delicate, not highly chitinized.

The second specimen (21. 11. 7. 12. ii) seems likely to belong to the same species, having been found with 21. 11. 7. 12. i, and I think it is a young state of *S. suluensis* in spite of a striking difference of appearance. The trabeculae are much more delicate and the fenestrae are very small; but, on the other hand, the frontal ornamentation and the peristomes are as in the other specimen. Some of the peristomes resemble those of 83. A in having a proximal extension of their cavity, of the kind shown in the middle zooecium of fig. 10. Munitiform avicularia are present, but those noticed are suprafenestral. I have found no ovicells.

S. longifissa and *S. suluensis* appear to be nearly related to *Sertella (Retepora) praetenuis* Hincks (1878, GR, p. 356, Pl. XIX, figs 6—8), on the evidence of specimens (99. 5. 1. 1252—1254) in the British Museum. The locality on the slides is Red Sea, and I think it is probably correct. In his published account, however, Hincks stated that, although *S. praetenuis* was said to have been taken from a telegraph cable in the Red Sea, he had found so many Mediterranean species mixed with this material that he was doubtful about the locality. He emphasized the delicacy of this species, not merely by the name he gave it, but also in his description. The long ovicell is much smaller than those of the two Siboga species, which it resembles in its form, in its median fissure and in the shape of its descending lamina and labellum. The frontal surface of the ovicell is almost flat, from the distal end of the fissure to the free edge of the labellum, in contrast with *S. suluensis*, in which there is an angle between the exposed and the descending parts. The labial avicularium, pore and suture are like the corresponding features of the Siboga species. The most distinctive character is the common occurrence of many large, raised, frontal avicularia, with elongate acute rostra, as described by Hincks. Owing to the amount of detritus on the surface of the specimens I am unable to state whether small or munitiform avicularia occur in addition.

Waters (1895, MZNR, p. 260) considered that *S. praetenuis* is a synonym of *Retepora marsupiata* Smitt (1873, FB, p. 67), from Florida. *Sertella (Retepora) fissa*, from Victoria, had

previously been described by MacGillivray (1869, PRSV, IX, p. 140); and in a subsequent memoir (1885, PZV, Dec. X, p. 18) he expressed the opinion that its more slender form might be identical with *R. marsupiata*. I am not satisfied that the identity of *Sertella praetenuis* with either *Sertella fissa* or *Sertella marsupiata* has been established.

4. **Reteporella** Busk.

Reteporella Busk, 1884, Chall., pp. 105, 126.
Reteporella Harmer, 1933, GR, p. 619.
Radulina Meissner, 1902, ATIB, p. 731.
Retepora (pars) auctt.

Zoarium typically ramose; or, if with anastomoses, with many of the fenestrae long and slit-like. Frontal pores seldom more than 1 pair, often inconspicuous or absent. Septal lines of young zooecia not produced as prominent ridges. Peristomes typically with a closed labial pore (probably sinuate in some species), a labial avicularium on one side of it; often with marginal denticles or teeth, the latter commonly produced into cylindrical or occasionally antenniform spines; these often found merely on a few of the youngest zooecia. In the two species here included the spine-bases of the marginal peristomes appear webbed, and this character probably occurs in other species. Ovicells not conspicuously narrow and pyriform (cf. *Reteporellina*, p. 580), becoming immersed and then not showing much more than the usually persisting narrow median fissure and the descending lamina, which has a straight or convex free edge not forming a distinct labellum; the lateral flanges absent or hardly recognizable.

Genotype, *Reteporella flabellata* Busk, 1884, Heard Id., S. Indian Ocean 75 fath.

R. flabellata was selected by me (1933) as the genotype after having examined Busk's type-slide (87. 12. 9. 514, Brit. Mus.). It appears to be a typical Retepore, except in the apparent absence of basal vibices. A closed labial suture connects the labial pore with the margin of the peristome. Its conspicuous antenniform spines differ from those of *Reteporella graeffei* only in having flat and wide segments. As they seem to be slightly calcified, it is possible that their flatness may be due to collapse on drying. Busk did not describe the ovicells, but one at least is present in his specimen. It is completely immersed, with a descending lamina apparently not produced into a distinct labellum; but, in the present condition of the specimen, I cannot be sure whether a median fissure is present or not. A proximally directed frontal avicularium occurs on many of the zooecia. The marginal peristomes in some instances show a trace of the webbing characteristic of *R. graeffei*. I agree with the conclusion of earlier authors that *R. myriozoides*, Busk's second species, does not belong to the Reteporidae.

Reteporella has often been described as inseparable from *Retepora*; on the ground that the two differ merely in zoarial habit. While admitting that this character by itself is not a certain guide to affinities, I think it should not be completely ignored. I have made an analysis of 23 previously described species which have the Reteporelliform habit. Some of these should, I think, be placed in *Reteporellina*, which according to my evidence belongs to the Pacific and Indian Oceans. As shown by their respective type-localities, 14 were from Torres Straits to Japan; 1 from the Sandwich Is.; 4 from the Indian Ocean; and 4 from the Atlantic. *R. flabellata*, the genotype, was from 75 fathoms in the colder part of the Indian Ocean. The Atlantic

species [1]) are *Reteporella spatulifera* (*Retepora spatulifera* Waters, 1905, BCH, p. 243), from near Cape Horn, 65—140 M.; *Reteporella prominens* Canu and Bassler (1928, BGM, p. 124) from the Caribbean Sea, 130 fath.; and *Reteporella ramulosa* (*Retepora ramulosa* Calvet, 1906, NBTT, p. 162; 1907, BTT, p. 454), 2, 330 M. and *Reteporella sparteli* (*Retepora sparteli* Calvet, 1906, NBTT, p. 163; 1907, BTT, p. 457) 717 M., both from the N. Atlantic. These facts indicate a centre of distribution in the W. Pacific, extending to the Indian Ocean and (in cold water) to the N. Atlantic; and they support the conclusion that the two genera (or one only if *Reteporellina* be not accepted) are assemblages of allied species.

I do not overlook the fact that the fissured ovicell of most species of *Reteporella* resembles that of *Sertella*, a genus with many species, with a similar ovicell. These two genera, if they are really distinct, may perhaps have been derived from a common ancestor. On the other hand, Reteporelliform species not belonging to this assemblage are known to exist. *Retepora solanderia*, as understood by Waters (1895, MNZR, p. 264) should probably be termed *Schizoretepora solanderia*; and on p. 555 I have above described a ramose species of *Iodictyum* (*I. spicatum*). The well marked genus *Triphyllozoon* has no known Reteporelliform species. The systematic study of the large number of species included by authors in Reteporidae is facilitated if those of Reteporelliform habit can be separated from the rest.

1. *Reteporella graeffei* (Kirchenpauer) (Pl. XXXV, figs 12—15; Pl. XXXVIII, figs 13—15; text-fig. 25. E, p. 519; text-fig. 31, p. 575; text-fig. 32, p. 576).

Retihornera graeffei Kirchenpauer, 1869, Mus. Godeffroy, Cat. IV, p. XXX; Fiji Is.
Kirchenpaueria elegans Graeffe, MS.; see Kirchenpauer, ibid., p. XXX.
Retepora graeffei Waters, 1888, Chall., p. 18 (syn. *R. producta* Busk).
Retepora graeffei Marcus, 1921, SSEA, p. 15. Cape Jaubert (N. W. Australia), 12 fath.
Retepora graeffei Livingstone, 1927, MBQ, p. 59 (no description). Queensland.
Retepora graeffei Hastings, 1932, PGBR, p. 439. Great Barrier Reef.
Retepora producta Busk, 1884, Chall., p. 108, Pl. XXV, figs 7—7*f*; text-fig. 17 (operc., mand.). Tongatabu, 18 fath.; Samboangan (Philippine Is.), 10 fath.
Retepora producta Kirkpatrick, 1890, TS, p. 612 (no description). Torres Str., 15—20 fath.
Retepora producta Thornely, 1907, MPIM, p. 193 (no description). Pedro Shoal (N. Ceylon), 25 fath.
Retepora producta Maplestone, 1909, PGI, p. 410 (no description). Gilbert Is.
Retepora producta Waters, 1913, BEA, p. 525, Pl. LXXII, figs 9, 10. British E. Africa 10—20 fath., Amirante Is.
Retepora producta Marcus, 1923, BAI, p. 433. Aru Is., Philippine Is.
Retepora porcellana, var. *laxa* Mac Gillivray [2]), 1884, PRSV, XX, pp. 112, 113 (no description), Pl. II, fig. 9 (operc., mand.); 1885, PZV, Dec. X, pp. 13, 15, Pl. XCIV, fig. 9 (operc.), Pl. XCV, figs 3, 6; ibid., 1890, Addenda, last page (syn. of *R producta*). Victoria.
? *Reteporella peripherica* Ortmann, 1889, JB, p. 36, Pl II, figs 26*a*, *b*. Japan, 35—100 fath.
Reteporella dendroides Ortmann, ibid., p. 36, Pl. II, figs 27*a*, *b*. Japan. 200 fath.
Retepora dendroides Okada, 1920, RAJ, p. 623, Pl. VIII, fig. 8 (zoarium). Japan, 120 fath.

1) Calvet (1931, BCAM) more recently introduced two Atlantic species of *Reteporella*, in neither instance figured; — *Reteporella jullieni* n. sp., p. 105, Azores, 1550—1600 M.; and *Reteporella* (*Retepora*) *incrustata*, nom. nud., p. 106, Cape Verde Is., 91 M.

2) There are discrepancies in MacGillivray's figures of opercula, 1884 and 1885, and it is not obvious which of them are to be considered correct. The operculum of var. *laxa*, 1885, fig. 9 is a modification of one of those figured as *R. porcellana*, 1884, fig. 8; and *R. porcellana*, 1885, fig. 8, is var. *laxa*, 1884, fig. 9. MacGillivray was probably mistaken in regarding the latter as a variety of *R. porcellana*, which is typically fenestrate and has very different ovicells.

Retepora dendroides Buchner, 1924, UJR, p. 195, Pl. XVI, fig. 5. (basal plate). Japan, 250 M.
Radulina semoni Meissner, 1902, ATIB, p, 731, Pl. LXVI, figs 1—4. Thursday Id. (Torres Straits).
? *Retepora* (*Reteporella*) *millespinae* Canu and Bassler, 1929, BPR, p. 367, Pl. XLVII, figs. 1—11. Philippine Is, 20—240 fath.

Group A. 57. A. Stat. 80. Borneo Bank, Strait of Makassar, 40—50 M. Several.
44. B. Stat. 77. Borneo Bank, Strait of Makassar, 59 M. Several.
237. A. Stat. 310. Sumbawa, E., 73 M. Fragments.
255. B. Stat. 311. Sapeh, E. Sumbawa, 0—36 M. Fragments.
221. A. Stat. 305. Solor Strait, E. of Flores, 113 M. Several.
270. D. Stat. 60. 303. Haingsisi, Samau Id., W. Timor, 0—36 M. Fragments.
218. D. Stat. 301. Rotti Id, E., S. W. of Timor, 0—45 M. Fragments.
Group B. 476. A. Stat. 96. Sulu Archipelago (Pearl Bank), 15 M. 1 col.
69. A. Stat. 99. Sulu Archipelago (N. Ubian), 16—23 M. 2 col.
389. A. Stat. 95. Sulu Archipelago, 522 M. Dead fragment.
471. A. Stat. 98. Sulu Archipelago, 350 M. 1 col.
77. A. Stat. 105. Sulu Archipelago, 275 M. Several.
84. B. Stat. 105. Sulu Archipelago, 275 M. Several.
478. A. Stat. 107. Sulu Archipelago, 270 M. Dead fragments.
486. A. Stat. 125. Siau Id., N. of Celebes, 0—27 M. 1 col.
488. D. Stat. 133. Lirung, Talaut Is., S. of Mindanao, 0—36 M. 1 col.
Group C. 107. E. Stat. 144. S. of Halmaheira (Djilolo), 0—45 M. Several.
501. M. Stat. 163. Seget, N. end of W. New Guinea, 29 M. Fragments.
137. A. Stat. 164. W. of N. end of New Guinea, 32 M. Numerous.
204. B. Stat. 282. Timor, E., 0—54 M. Fragments.
Locality not recorded. 374. E. Fragments.

British Museum.: —

Tongatabu, 87. 12. 9. 460, 462 and 99. 7. 1. 3158; Samboangan (Philippine Is.), 87. 12. 9. 461, 463 and 99. 7. 1. 3154 (Challenger Coll.); — also Sandwich Is., 99. 7. 1. 3159. 3160. All BUSK Coll., as *Retepora producta*.

Cambridge, Mus. Zool.: —

Victoria, Miss E. C. JELLY, Reg. May 24, 1895.
Torres Straits, A. C. HADDON Coll. 78, 148, 152, Reg. Feb. 24, 1898.
Torres Straits, A. C. HADDON Coll.; determined by KIRKPATRICK as *R. producta*. Reg. May 26, 1900.
Seychelle Is., J. J. LISTER.

Zoarium (Pl. XXXV, figs 12—15) ramose; or, if with anastomoses, generally with approximate subparallel branches forming fenestrae of inconstant size, generally elongate and slit-like. Zooecia elongate-hexagonal, with a pair of conspicuous frontal pores. Peristomes dimorphic, the fertile ones without a distal wall, the ordinary ones more or less emarginate distally. Marginal peristomes projecting into the fenestrae, tubular basally, almost constantly with 1 inner and 4 outer short spine-bases, each produced into a long jointed or unjointed spine, the bases of the outer spines diverging, the wall of the peristome connecting them as a sort of web. Median peristomes much raised proximally, the orifice usually with 3 conspicuous denticles, sometimes accompanied by 3 marginal teeth and by a pair of long spines, often represented merely by their bases. Labial pore connected with the edge of the peristome by an external labial groove of varying length (text-fig. 25, E, p. 519). Labial avicularium small, or less often large and forming a tumid swelling on the wall of the peristome. A small avicularium, round or more

elongate, generally present frontally between the two pores; and others, less common, of great size, wide and long, with a much raised acute incurved beak, elsewhere on the same surface. Ovicells inconspicuous, becoming so much immersed that their narrow and short median fissure is the only part recognizable. In the older state the frontal surface is complicated by the appearance of longitudinal series of prominent mammillae. Operculum (text-fig. 31) wider than long, sometimes with a distinct marginal sclerite. Mandibles small, rounded and toothed; or very acute, small or large.

Fig. 31. — *Reteporella graeffei*. 137. A². Opercula (2), large and small mandibles. Obj. DD

WATERS (1888, Chall. p. 18) published the statement, based on KIRKPATRICK's examination of a specimen from the Museum Godeffroy in the British Museum, that *Retepora producta* Busk is a synonym of *Retihornera graeffei* Kirch. From my own study of the specimen I can confirm this conclusion, which has been accepted by Miss HASTINGS (1932) as probable. KIRCHENPAUER's statement that the spine-bases are connected by "eine kalkige, die Zellenmündung umgebende Membran" is significant, and I think that his trivial name should be accepted.

MARCUS (1921, p. 16) considered *Reteporella peripherica* Ortm. a possible synonym of the present species; and in 1922 (IPBS, p. 15) he gave *R. dendroides* Ortm. as a synonym of *Retepora denticulata*. In both species ORTMANN had described jointed spines, especially on the marginal zooecia; and small rounded frontal avicularia. I think that both names are synonyms of *R. graeffei*; and both forms of colony shown in his figures occur in this species as represented in the Siboga Collection. As indicated by WATERS (1913), *R. producta* was recorded by MACGILLIVRAY from the Tertiary of Victoria. JULLIEN and CALVET's record (1903, BCH, p. 133) of it, without description, from the Azores, 1300 M., may be regarded as improbable.

Considering the numerous localities in which *R. graeffei* was found by the Siboga, particularly in or near the Sulu Archipelago, it seems hardly likely that it was absent from CANU and BASSLER's Philippine Is collection. Their diagnoses of Reteporidae are, however, unsatisfactory; and their photographic representations are ill adapted to bring out the specific characters in this difficult Family. *R. graeffei* may perhaps occur under more than one name in their memoir; but their species which seems best to agree with it is *Retepora (Reteporella) millespinae*. The "large hollow tuberosities" they mention are probably the characteristic mammillae of *R. graeffei*; the "small poriform avicularium placed on the median zooecial axis", the large number of spines and the "spiramen-fissure .... placed on the frontal" point to this conclusion. Their *Retepora (Reteporella) spinosissima* (p. 364) may be another synonym, but the spine-bases shown in their fig. 2 (Pl. XLVI) are not like those of *R. graeffei*. I suspect that this figure had been emphasized in certain details by the artist, perhaps not always correctly.

The zoarium is often without fenestrae, especially in the young state, the branches 2—9 serial. The septal ridges are hardly more than lines, marginal valleys being practically wanting. The primary orifice (Pl. XXXVIII, fig. 14) is minutely beaded or denticulate, with 2 lateral

condyles. The amount of projection of the peristomes varies, the raised lateral edges descending completely to the frontal surface in the fertile ones, the emargination being incomplete in the ordinary ones, which have a basal, tubular part of inconstant length. The labial groove of the median peristomes (those not marginal) is generally conspicuous (text-fig. 32, A), the proximal edge of the orifice being often almost straight or slightly concave, the peristome then appearing

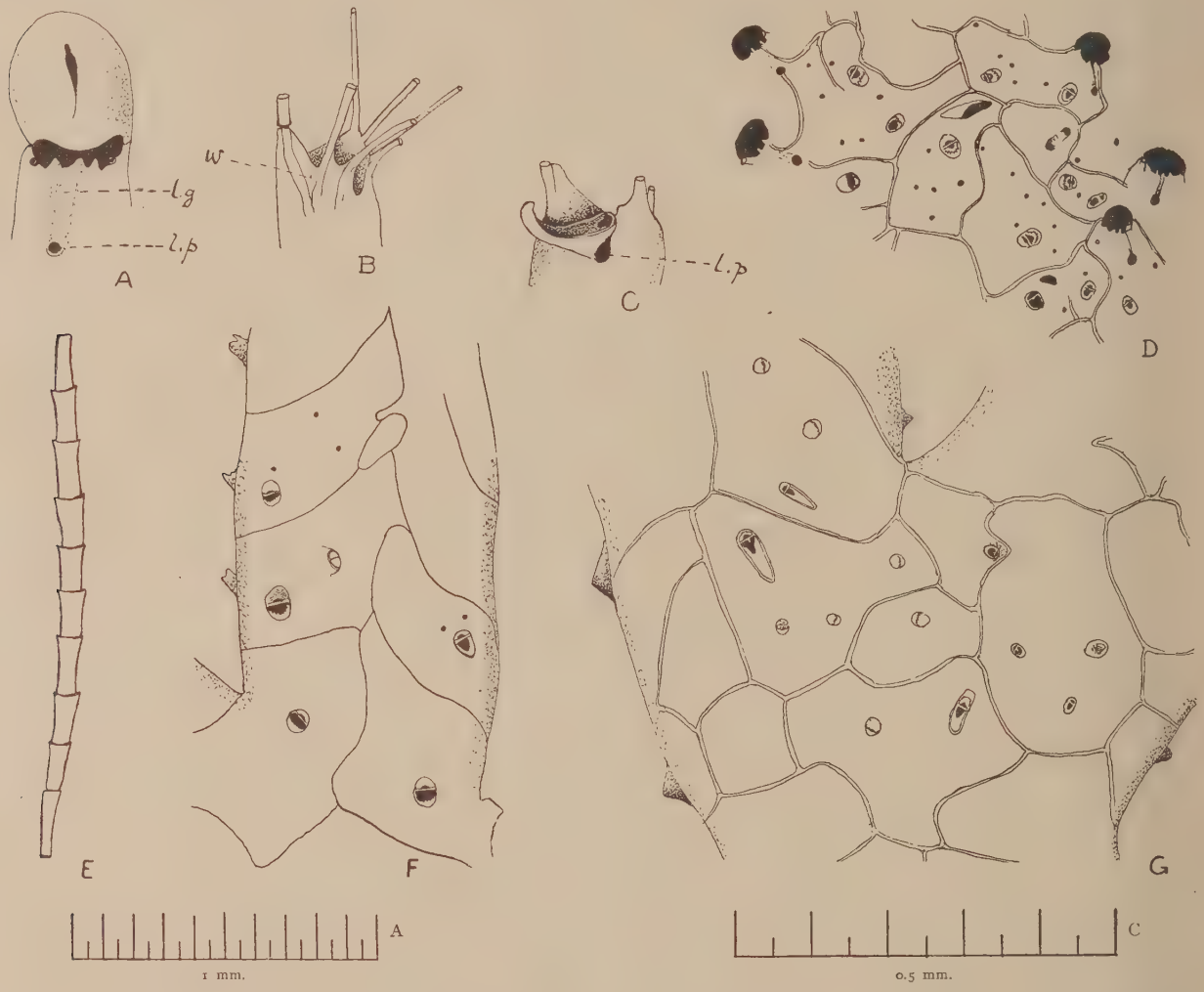

Fig. 32. — *Reteporella graeffei.* — A, 221. A; fertile peristome and young ovicell. B, 486. A; young peristome with spine-bases. C, same slide; young peristome and long labial avicularium. D, 204. B; central region of colony, the orifices partly occluded by kenozooecia. E, 486. A; antenniform spine. F, 137. A[1]; basal surface, the kenozooecia biserial. G, same slide; slightly older part of the basal surface, with irregular kenozooecia. — A, B, C, E, Obj. C; D, F, G, Obj. A. In D, F and G the avicularia are in various stages of occlusion by secondary calcification. — *l. g*, labial groove; *l. p*, labial pore; *w*, web formed by the edge of the peristome, connecting the tubular cavities of the spine-bases.

to consist merely of a lower lip. The frontal avicularia (Pl. XXXVIII, fig. 13) are of the following kinds; — (1) median, small, between the two pores, directed proximally, the finely denticulate rostrum often hardly more than a semicircle, but sometimes larger and relatively longer. This may be replaced, specially on a zooecium succeeding an ovicell, by a pair, symmetrically placed, at some distance from the middle line, on the distal side of the ovicell. The small avicularia may be more numerous, at least 3 on a zooecium, and are variable in position

and orientation; (2) a similar labial avicularium, raised and projecting as a short bracket, occurs on one side of the labial groove, the rostrum facing frontally; (3) a much larger labial avicularium, forming a conspicuous swelling on one side of the peristome (Pl. XXXVIII, fig. 15), its palatal surface transverse and vertical, lying deeply in the peristome, facing its cavity and thus seen edgeways in frontal view; (4) oblique avicularia, sometimes very large (Pl. XXXVIII, fig. 13), produced into a sharp, much raised incurved beak, the margins of the rostrum often denticulate; sometimes with a rounded end (as in 221. A).

Secondary calcification is accompanied by the development of large, conspicuous rounded mammillae, commonly one on either side of each zooecium, forming longitudinal series between the rows of zooecia. The peristomes become completely immersed, leaving no trace of their denticulate margin, and are now represented by deep depressions which may be nearly circular or even sinuate. The persistence of the labial pore shows that the sinus is not that of a typically sinuate peristome; and this pore remains long uncovered, doubtless at least so long as it is required by the living, active zooecium. The alterations of the surface are sometimes due to the development of kenozooecia (text-fig. 32, D), limited by prominent vibices not corresponding with the septal lines; often with several or many pores. An island of kenozooecia may have unaltered peristomes on its proximal and distal borders. Many of the avicularia, large and small, are developed secondarily on the kenozooecia, the original avicularium having been entirely occluded.

The primary ovicells (text-fig. 32, A) are slightly wider than the peristomes, rather longer than wide, hardly narrowing proximally. The frontal vacuity closes as a narrow fissure, and the region of the slit is generally the only part which remains uncovered (Pl. XXXVIII, fig. 13). The fissure is visible on the distal wall of peristomes altered by large frontal mammillae; and numerous ovicells are present in parts of the colony in which they may easily be overlooked. The frontal wall of the ovicell extends a short distance down the peristome, ending in a straight or slightly convex free edge. The labellum is either wanting or is at most represented by a slight convex prolongation of the frontal wall (text-fig. 32, A; see also Waters, 1913, Pl. LXXII, fig. 10); the angles at its sides being hardly distinct enough to describe as lateral slits.

The basal kenozooecia are originally biserial (text-fig. 32, F). Secondary kenozooecia (G) may be numerous, smaller, of inconstant shape, usually with 1 or 2 basal pores and a minute, circular avicularium or a larger and acute one; the surface with fine granulations, among which there may be a few much larger, subconical tubercles.

The distribution, as shown by the Siboga Collection, is as follows. Stations 60 and 305—311 are from the southern fringe of islands; 77 and 80 being from the southern half of the Strait of Makassar; Stations 95—133 are from the northern side of Celebes to the Philippine Is and the Sulu Archipelago; Stations 144—282 are from the southern point of Djilolo, the western end of New Guinea and the east end of Timor. With the exception of Stat. 305, E. of Flores, 113 M., all specimens from dredgings of more than 100 M. are from the Sulu Archipelago, 270—522 M. *R. graeffei* seems to be more common in the northern part of the area than *Reteporellina denticulata* (see p. 581), which was not represented from the Strait of Makassar.

R. graeffei appears in many disguises, and separated fragments of a single colony might

be referred to different species. In the young state in particular it cannot always be distinguished from *Rēteporellina denticulata* unless examined microscopically. If even moderately young branches are available it may be recognized by its long spines, 1 inner and 4 outer on marginal zooecia, their bases connected by a short web, and 1 pair on the other zooecia; by the labial pore and groove; by the marginal denticles, usually 3, of which 2 are opposite the edges of the labial groove and 1 opposite the labial avicularium; by the characters of the ovicells; and, in the old state, by its mammillated surface. The constancy of the number of spines and denticles is remarkable; variations being rare. Doubt has been expressed by Waters (1913) and Marcus (1921) with regard to definite jointing of the spines. They seem to be always jointed at the base, but in the most slender spines jointing cannot always be detected. Other spines, often on the same colony, may have at least 11 segments, in the largest ones each widening from a narrow base, so as to become antenniform (text-fig. 32, E). When growth is ceasing at the ends of branches, there is a tendency to replace marginal denticles by marginal teeth.

The small median frontal avicularium is characteristic, although it is not always present, nor always median. Waters (1913) remarked that "these avicularia do not occur on the younger zooecia but are common on the others". This may be a correct description of a particular colony, but the avicularia do not defer their appearance until their zooecia are distant from the growing edge. They are in fact primary structures, developed with their zooecia at the margin. Secondary avicularia, associated with frontal kenozooecia, may appear later, generally with inconstant orientation.

The large frontal avicularia (Pl. XXXVIII, fig. 13) are variable in their occurrence and size. They may be found specially on marginal or submarginal zooecia, with an obliquely distal orientation towards the middle of the branch. They are usually unicuspid, and in a Torres Straits specimen (148) the beak is specially long, raised, incurved and acute, sometimes with indications of 2 subsidiary cusps; — an approach to the trifid condition described by Busk. In 204. B they are particularly numerous on trabeculae which unite adjacent branches. One such connexion is biserial, having an avicularium of this kind on practically every zooecium, thus forming two alternate series, the acute beaks all directed towards the middle of the trabecula, nearly transversely but with a slight distal obliquity. A connecting trabecula in this specimen is entirely a derivative of one of the united branches.

The swollen unilateral avicularia (Pl. XXXVIII, fig. 15) of the peristomes occur in many specimens. The ordinary labial avicularia usually project proximally, where they are much raised. In 218. D the avicularium is raised about half way up the peristome and is at the bottom of a deep proximal emargination of the orifice. As the usual distal deficiency occurs as well, the marginal part of the peristome is reduced to two long lateral lobes, the avicularium at their base, close to the labial pore, which is connected with the bottom of the emargination by an unusually short groove; — other peristomes being normal.

486. A (text-fig. 32, C) differs from all the others in its labial avicularia, which are normally placed but are more than double the usual length; the rostrum, facing mainly frontally, being elongate and narrow, ending in a conspicuous upturned beak; the mandible acicular with a decurved point. A few peristomes have normal avicularia. The spines (text-fig. 32, B) are specially long, the proximal inner one of the marginal zooecia larger than the rest and conspicuously

antenniform (E), with numerous joints, each widening to its end. A thin inner spine may occur distally to the principal one, and there may also be a median distal spine, making a continuous circlet of 7. The two spines of the median zooecia are mostly large and antenniform. The frontal avicularia are generally normal, but one or two resemble the modified labial avicularia of this specimen. The fissure of the ovicell is wider than usual, and it seems to be a vacuity of the ectooecium alone; the entooecium having completely closed. The mammillate frontal surface of the older parts is typical.

The deep water specimens agree essentially with the others. 221. A (Pl. XXXV, fig. 12) has long branches, mostly parallel to one another but with no anastomoses; which do not seem to occur in specimens from more than 100 M. These indicate that *Radulina semoni* Meissner is a synonym of *R. graeffei*. Nearly all details of MEISSNER's fig. 3; — the fluted peristome, the labial groove and pore and the profusion of small avicularia might have been drawn from 221. A, in which, as in other deep water specimens, small avicularia are very numerous.

A calcined portion of 57. A shows many jet-black, sharply defined crescents which must represent the opercula and can be seen *in situ* in some zooecia. These seem to imply that the lateral and distal parts of the opercula are more chitinous than the proximal part, which was too soft to leave any traces after having been heated. Some confirmation of this is given by Canada balsam preparations of 137. A.

2. *Reteporella obtecta* (Buchner) (Pl. XXXVIII, figs 16—18).

Retepora obtecta Buchner, 1924, UJR, p. 196, Pl. XVI, fig. 12; text-fig. Q (operc., mand.). Japan, 600 M.

(nec *Retepora obtecta* Canu and Bassler, 1927, 1928, BIH, p. 28, Pl. VI, figs 6, 7. Sandwich Is., 58—483 M.)

Group C. 168. D. Stat. 251. Kei Is., 204 M. Fragment.

Cambridge, Mus. Zool.:

BM Japan, 40 fath. OWSTON Coll. 5. AX. Reg. June 23, 1902.
BM Japan. MITZOBUCHI Coll. Reg. Feb. 1. 1901.

Zoarium ramose, dichotomous, without anastomoses; branches 2—5 serial. Marginal peristomes slightly longer than the others, projecting, shortly tubular, sometimes curved; their walls containing the tubular bases of spines, as in *R. graeffei*. The edges of old peristomes (fig. 17) show small projections which are not the remains of spines. Labial pore close to the edge of the orifice, one side generally prolonged into the inner margin of a projecting, raised tooth. A unilateral inflation of the peristome indicates the presence of a labial avicularium, the rostrum of which seems to be placed deeply in the secondary orifice. Primary frontal avicularia (fig. 18) few, small, not more than one on a zooecium. Secondary avicularia (figs 16, 17) excessively numerous on the old parts, very small, mostly elongate and narrowly triangular; others shorter, the rostrum and mandible apparently in all cases rounded. Primary ovicells at least as wide as the peristomes, early immersed (fig. 17); the median portion, which has a longitudinal fissure of varying width, remaining exposed. Descending lamina with a wide, straight or slightly convex free edge, not ending in a distinct labellum. Frontal surface, even near the growing margin, covered by numerous irregular tubercles, coalescing and giving rise to a honeycomb-like

surface. Large mammillae developed in two longitudinal rows (as in *R. graeffei*), usually on either side of a peristomial depression and corresponding with the middle regions of the zooecia of adjacent rows. Basal surface with very numerous small tubercles, the vibices indistinct, the avicularia like those of the front, but not common. Characters of opercula and mandibles not ascertained.

R. obtecta is distinguishable from *R. graeffei* by the absence of anastomoses between the branches, by the position of the labial pore practically on the edge of the orifice, by the details of the orifices and by the secondary avicularia, which are very different from those of other Reteporidae found by the Siboga. The youngest branch, in which growth had apparently ceased, has a median terminal zooecium (fig. 18). The young zooecia are very thick-walled and have nearly flat frontal shields, separated by inconspicuous septal lines, without marginal valleys or pores. The peristomes become early immersed, then forming subcircular deep depressions. Most parts of the colony are much altered by secondary calcification, not showing either septal lines or vibices. The oldest parts (fig. 16) are remarkable for the profuse development of small avicularia, one of which is on a calcareous plate closing an orifice.

My description is based on a single unsatisfactory Siboga specimen, parts of its frontal surface being very irregular. This is due largely to the occurence of superficial calcareous tunnels, probably formed in response to the stimulus given by a Hydroid (cf. p. 570).

The Cambridge Collection includes two specimens from the type-locality (Japan). They agree with BUCHNER's account in having small and obliquely placed labial avicularia, the palatal surface of which is partly visibly in frontal view. Most of the frontal avicularia (MITZOBUCHI's specimen, old) are nearly circular, but larger avicularia also occur and they are more frequent in 5. AX (young). The latter is much more delicate than the old specimen.

The available material is insufficient for a comparison of *R. obtecta* with other Japanese *Reteporella*, of which several species have been described by ORTMANN (1889) and OKADA (1920).

CANU and BASSLER (see synonymy) gave no sufficient reasons for their determination of Sandwich Is. material as *Retepora obtecta*. The zoarium of these is stated to have been maeandrine, with small fenestrae; and these characters at least do not agree with BUCHNER's species, which was described as being of the *Reteporella*-type and as branching in one plane.

5. **Reteporellina** Harmer.

Reteporellina Harmer, 1933, GR, p. 625.
Retepora (pars) and *Reteporella* (pars) auctt.

Zoarium ramose, Reteporelliform, not fenestrate; or, if with anastomoses, having many of the fenestrae long and slit-like. Frontal pores seldom more than one pair, often inconspicuous or absent. Peristomes frequently cylindrical or tubular, with marginal teeth or marginal denticles; sinuate or with a closed labial pore. Oral spines wanting in the species examined. Frontal avicularia various, a strongly bicuspid avicularium being characteristic but not always present. Ovicells typically elongate and pyriform, wider distally, often with a narrow, persistent, median fissure or groove, the small labellum distinct but not carinate; lateral sinuses wanting; lateral flanges extending proximally considerably beyond the labellum.

Genotype, *Retepora denticulata* Busk, 1884 (HARMER, 1933).

Reteporellina agrees with *Reteporella* in the *facies* of the zoarium, but differs from it in the absence of spines (as distinguished from marginal teeth) on the peristomes, as well as in the characters of the ovicell; — that of *Reteporella* showing no more than a vestigial labellum and not having long and conspicuous lateral flanges. The four species here described appear to form a very natural group occurring in the Pacific and Indian Oceans. The genus probably includes some of the species which have been placed in *Reteporella* but have not been described with sufficient precision to justify their removal to *Reteporellina*.

Key to the species of *Reteporellina* here recorded.

1	Zooecia exceptionally large, the peristomes strongly tubular, with much everted secondary orifices, the sinus not visible externally. Avicularia very large, labial or lateral, much widened distally. Ovicell surrounded by a high crater-wall	2. *R. idmoneoides* n. sp. (abyssal).
	Zooecia of moderate size. Peristomial sinus or labial pore visible externally	2
2	Peristome with a closed labial pore. Fertile peristomes widely expanding, composed of two thick lateral halves with exceptionally strong internal longitudinal ridges; the wall deficient proximally and distally, not crossing the ovicell. Frontal avicularia large, triangular, acute	3. *R. capistrata* n. sp. (abyssal).
	Peristome sinuate, with marginal teeth but without definite marginal denticles other than the sinus-denticles or ridges	3
3	Ordinary peristomes with a nearly circular orifice. Lateral flanges of ovicells very high at the middle, easily visible even if the fertile peristome becomes secondarily complete. Avicularia not found .	4. *R. laxipes* (abyssal).
	Peristomes variable. Ovicells concealed by secondary calcification, with the exception of the median fissure. Some of the frontal avicularia, which are often large, conspicuously bicuspid . , .	1. *R. denticulata* (mostly shallow water).

1. *Reteporellina denticulata* (Busk). (Pl. XXXV, figs 21—23; Pl. XXXVIII, figs 27—32; text-fig. 25, D, p. 519; text-fig. 33.

Retepora denticulata Busk, 1884, Chall., p. 109, Pl. XXVI, figs 1*a—d*; text-fig. 18 (operc., mand.). Sandwich Is., 20—40 fath.
Retepora denticulata Philipps, 1899, WZR, pp. 440, 449, Pl. XLIII, fig. 13. Lifu, Loyalty Is.
Retepora denticulata Calvet, 1906, BA, p. 620, Pl. XXI, figs 2—9 (5—9, operc., mand.). Amboina.
Retepora denticulata Thornely, 1912, PIOS, p. 147. Amirante Is., 15—35 fath.; Seychelle Is., 34 fath.
Retepora denticulata Waters, 1913, BEA, p. 526, Pl. LXXII, fig. 8 (muscles). British E. Africa, 10 fath.
Retepora denticulata Marcus, 1922, IPBS, p. 15. Gaspar Strait (Malay Archipelago).

Retepora worsleyi MacGillivray, 1887, PRSV, XXIII, pp. 184, 185, Pl. II, figs 2—2*b*. Gaspar Strait, 17 fath.
Retepora apiculata Thornely (non Busk), 1905, PGM, p. 125 (no description). Ceylon.
Retepora abyssinica Waters, 1909, SRS, p. 176, Pl. XVIII, figs 1—10 (4—6, operc., mand.). Red Sea, 30 fath.
Retepora abyssinica, var. *expansa* Waters, 1910, SRS, p. 254. Red Sea.
Retepora misakiensis Okada, 1920, RAJ, p. 616, Pl. VIII, fig. 1 (zoarium), text-fig. 1*a*—*e* (*c*—*e*, operc., mand.). Japan, shallow water.
Retepora misakiensis Buchner, 1924, UJR, p. 190, Pl. XV, figs. 7, 7*a*, 8. Japan, shallow water.
? *Reteporella* ? sp. Thornely, 1907, MPIM, p. 194, text-fig. 8. Andaman Is., 238—290 fath.

Group A. 9. B. Stat. 33. Pidjot Bay, Lombok, 0—22 M. 1 col.
286. C. Stat. 33. Pidjot Bay, Lombok, 0—22 M. Fragment.
237. B. Stat. 310. Sumbawa, E., 73 M. Fragments.
349. B. Stat. 60, 303. Haingsisi, Samau Id., W. Timor, reef. Fragment.
214. C. Stat. 299. Rotti Id., S. W. of Timor, 0—34 M. 1 col. (probably).
Group B. 617. A. Stat. 99. Sulu Archipelago (N. Ubian), 16—23 M. Fragment.
475. B. Stat. 105. Sulu Archipelago, 275 M. Fragments.
Group C. 107. A. Stat. 144. S. of Halmaheira (Djilolo), 0—45 M. Numerous.
353. E. Stat. 240. Banda, Banda Sea, 0—45 M. 2 col. (young).
358. A. Stat. 240. Banda, Banda Sea, 0—45 M. Several (large).
165. C. Stat. 248. Tiur Id., between Ceram and Kei Is., 0—54 M. 1 col.
177. J. Stat. 257. Kei Is., 0—52 M. Fragments.
298. C. Stat. 273. Jedan, Aru Is., 13 M. Several.
208. D. Stat. 282. Timor, E., 0—54 M. 1 col.

British Museum: —

Sandwich Is., 20—40 fath., Challenger (Busk's type-material), 87. 12. 9. 464, 465; 99. 7. 1. 3030, 3031.
Christmas Id., Indian Ocean, 46 fath. 10. 11. 2. 4.

Cambridge, Mus. Zool.: —

Victoria, Miss E. C. Jelly, Reg. May 24, 1895.
Port Jackson, Miss E. C. Jelly, Reg. May 24, 1895.
Lifu, Loyalty Is., A. Willey Coll., Reg. Mar. 1, 1898.
Torres Straits, A. C. Haddon Coll. 13, Reg. Feb. 24, 1898.
Japan, 40 fath., A. Owston. Coll. 5. Y, Reg. June 23, 1902.
Japan, Mitzukuri Coll., 4, Reg. Sept. 23, 1896.
Ceylon (received from Miss Thornely as *R. apiculata*), Reg. Apr. 25, 1906.

Zoarium (Pl. XXXV, figs 21—23) more or less cup-shaped, reaching a diameter of at least 37 mm.; if reticulate usually with narrow, very elongate fenestrae of inconstant form, the branches rarely united by barren trabeculae; or, especially in the young state, without anastomoses, dichotomously dividing. Branches 2—9 serial. Young zooecia with low septal ridges, enclosing elongate-hexagonal areas almost filled by the frontal shields, the marginal valleys narrow or evanescent. Pores 2, less often 3, conspicuous, at some distance from the proximal end. Peristomes variable, their openings infundibuliform, conspicuously and variously toothed, the marginal peristomes long and subtubular, curving outwards; distal lip deeply emarginate in both kinds of peristome. Proximal margin of secondary orifice obviously sinuate, but the sinus evanescent or absent in the Port Jackson specimen. Marginal denticles wanting except the two parallel and closely approximated sinus-ridges, which extend down the whole length of the peristome and delimit a sharply marked sinus-groove (text-fig. 25, D, p. 519). Frontal avicularia variable in their frequency, typically strongly bicuspid, but unicuspid in certain colonies. Large infrafenestral

vicarious avicularia rare, their rostrum widening greatly at its distal end, which is usually 3—5 toothed. Primary ovicells delicate, thin-walled, small, pyriform; the small labellum continuing the frontal wall of the ovicell in the same plane; the lateral flanges extending considerably beyond it down the peristome and uniting with one another proximally; the frontal surface with a longitudinal fissure, its distal end slightly raised or even minutely spiked. Basal avicularia acute, unicuspid (rarely bicuspid), not uncommon at the margins of the branches, their orientation transverse, proximal or otherwise. Mandibles of frontal avicularia elongate, with 2 (rarely 3) acute teeth at the extremities of the truncate distal end. Infrafenestral mandibles expanding widely at the distal end, which is produced into 3—5 triangular teeth.

The most distinctive characters are the remarkable infrafenestral avicularia; the bicuspid labial or frontal avicularia, with mandibles ending in 2 (less often 3) acute points; the sinuate peristome; and the elongate, narrow and pyriform primary ovicells.

R. denticulata is a species of wide distribution, extending in the Pacific from Victoria to Japan and the Sandwich Is; and in the Indian Ocean recorded from British E. Africa, Ceylon (as *R. apiculata*) and possibly from the Red Sea (as *R. abyssinica*). The records of the Siboga are from the S. side of the southern fringe of islands, from Lombok to W. Timor (Stations 33, 60, 299 and 310); the Sulu Archipelago (Stations 99, 105); and the S. end of Djilolo to E. Timor (Stations 144—282).

One of the characters mentioned by Busk, in introducing the species, is the occurrence of barren trabeculae (without zooecia) uniting the branches; as in *R. apiculata*, which he placed in the same group of species. This arrangement does not seem to have been noticed by any subsequent author, and I have found it solely in the specimens from the Loyalty Is.

A large amount of variation occurs in the peristomes, which in Busk's type-material are relatively not very prominent. In young Siboga specimens (Pl. XXXVIII, fig. 27) they are extraordinarily beautiful, the marginal ones with graceful expanding orifices, often bilabiate and with strongly developed acute marginal teeth or more rounded lobes. Except in the Port Jackson specimen they are constantly sinuate (text-fig. 25 D, p. 519), the position of the long sinus-groove indicated by a longitudinal fold on the outer side of the proximal wall of the peristome, the distal margin of which is emarginate. Dimorphism is at first sight not apparent, but in the fertile peristomes the distal emargination extends to the frontal surface of the zooecia, while in the others there is a short, completely tubular basal portion. In one or two instances the peristome has a distinct distal sinus, limited by two strong denticles, at some distance from the orifice. This seems to be due to a secondary closure of the distal peristomial emargination.

The characteristic avicularia of the frontal surface (Pl. XXXVIII, fig. 28) occur in the neighbourhood of the peristomes and should probably be regarded as labial avicularia. In some instances they are small, the rostrum directed obliquely proximally towards the sinus, but more usually standing nearly vertically in the wall of the peristome, the palatal surface facing the distal end of the zooecium. When the avicularium is larger, its base may extend over much of the frontal shield, the bicuspid apex remaining vertical. In other avicularia the rostrum is nearly horizontal, extending from one side of the peristome across the middle line and facing frontally. In some instances the avicularium does not reach the peristome and is completely frontal. These avicularia may be sparse, as stated by Busk, but in other specimens they are

found on practically every zooecium, and they are then usually large, with two prominent incisor-like cusps. In one or two specimens the avicularia of the frontal surface are unicuspid, and in others these occur with bicuspid avicularia on the same branch. In 617. A, a very young colony, I have found solely unicuspid avicularia. In 358. A, nearly all the frontal avicularia are unicuspid, but a few are bicuspid. In all other instances, including the type-material, I have found bicuspid avicularia, one of which can be recognized in the uppermost right zooecium of Busk's fig. 1*b*. The 2-pronged mandibles (text-fig. 33, A—C) are visible *in situ* on bicuspid avicularia in certain dry preparations; and I think they are restricted to these avicularia, and that when an avicularium is unicuspid its mandible is simply acute.

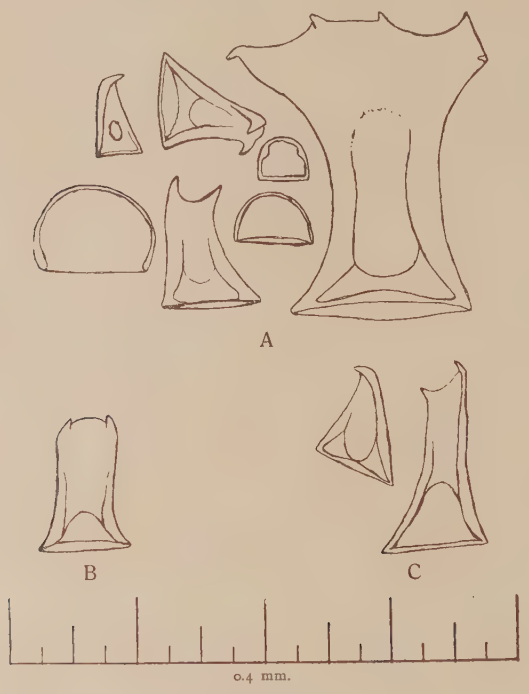

Fig. 33. — *Reteporellina denticulata*. A, 9. B³. Operculum, large infrafenestral mandible, bicuspid mandibles (2), acute mandible and small round mandibles (2). B, Mus. Cambr., Port Jackson. Bicuspid mandible. C, ibid., Loyalty Is. Acute and bicuspid mandibles. Obj. DD.

Canada balsam preparations (text-fig. 33, A) show a few minute semicircular mandibles. I have not identified the corresponding avicularia in dry preparations, but they may be the minute ones mentioned by Busk as occurring on one side of the sinus. A slide from the Port Jackson material has mandibles (fig. 33, B), probably of bicuspid avicularia, in which the terminal prongs are reduced to two minute points. Busk and Miss Thornely (1912) both mentioned the infrafenestral avicularia, of which a description was later given by Calvet, who first figured it and its characteristic large mandible (his figs 4, 9). In the Siboga material (Pl. XXXVIII, figs 29, 30) they are not common, but I have found them in 9, B, 165. C, 208. D, 237. B, 298. C, 353. E and 358. A. These are mostly quite small colonies; and the fenestral avicularia may perhaps be produced principally during early stages of growth. The large and greatly widened mandible is shown in text-fig. 33, A.

Calvet was also the first to give a satisfactory account of the ovicells, and I can confirm its accuracy. The narrowness of most of them, as shown in his fig. 4, is obviously due to the fact that the branch represented was moderately old and the ovicells had been partially immersed, as may be verified by most of the Siboga specimens (Pl. XXXVIII, fig. 28). Calvet's account was unnecessarily criticized by Waters (1913). In most of my specimens the primary ovicell (figs 31, 32) is pyriform. Some ovicells from the Loyalty Is. are of the same form, but others are wider, as shown by Miss Philipps in her fig. 13. The specimen from Port Jackson has distinctly large and wide ovicells.

With secondary calcification all parts acquire an entirely different aspect (fig. 28). The projecting margins of the peristomes disappear and their orifices become deeply sunk; for some time showing a sharply marked, narrow sinus, the bicuspid apex of the avicularium visible on one of its sides. The ovicells become almost completely covered by contributions from the adjacent zooecia, the frontal fissure remaining exposed.

In the older parts of 358. A (with principally unicuspid avicularia) all the orifices are deeply sunk and each is connected with its four alternate neighbours by a straight vibex, as in Pl. XXXVIII, fig. 5, *Sertella granulata*. The vibices thus enclose rhombic areas, the four sides approximately equal; and each such area bears 2 or 3 conspicuous pores. The projections of the peristomes have been completely lost, but the median fissures of the ovicells are visible in the distal parts of the depressed orifices. This so closely corresponds with the arrangement shown by WATERS (his fig. 9) in *Retepora abyssinica* that, taking other parts of his account into consideration, it may be suggested that this species should be termed *Reteporellina abyssinica*, but is probably an old state of *R. denticulata*; a conclusion supported by the characters of *R. abyssinica* var. *expansa* Waters, also from the Red Sea; in which the avicularium is "in the aperture" and is usually bifid.

The basal surface at first has biserial kenozooecia with rather indefinite, small tubercles and 2—3 marginal pores. It is greatly altered later by the superposition of secondary kenozooecia, which usually have 1—2 basal pores.

In several of the mounted young specimens the basal plate is seen to commence as a series of delicate, radially elongate and slightly convex kenozooecia, each with a conspicuous frontal pore and sometimes bearing unicuspid, acute avicularia. Kenozooecia of a smaller size may occlude the region of the ancestrula. MARCUS (1922) has suggested that the pores seen on the margins of branches may indicate the occurrence of rootlets. These apertures must certainly be regarded, however, as marginal pores of the nature of septula, normally occurring in Reteporidae, both frontally and basally.

The fragments 475. B are the only ones from deep water (275 M.). The characters of the peristomes, which are thick-walled, and of one or two ovicells present justify their reference to this species. No avicularia were found.

It seems clear that *Retepora worsleyi* MacGill., from the Gaspar Strait at the N. W. end of the Java Sea, is a young, non-fenestrate condition of the present species. MARCUS recorded *R. denticulata* from the same locality, and the Siboga Collection includes specimens from Stat. 33, at the S. E. end of the same Sea. MACGILLIVRAY described a strongly fluted, sinuate peristome; and the bicuspid apices of avicularia are shown in three zooecia of his fig. 2*a*. Young specimens of *R. denticulata* in the present collection correspond closely with his description and figures.

Retepora misakiensis Okada may be regarded as another synonym. This is indicated by the characters of the zoarium shown by OKADA in his Pl. VIII, fig. 1; of the peristomes (his text-fig. 1*b*); of the bicuspid frontal avicularia (OKADA, fig. 1*a*; BUCHNER, 1924, Pl. XV, fig. 7); of their 2-toothed mandibles (OKADA, fig. 1*e*); and of the ovicell (BUCHNER, fig. 7*a*).

2. *Reteporellina idmoneoides* n. sp. (Pl. XXXV, fig. 19; Pl. XXXVIII, figs 25, 26; text-fig. 34).

Group C. Type 112. C. Stat. 156. W. of Waigeu Id., 469 M. 1 fragment.

Zoarium (Pl. XXXV, fig. 19) ramose, dichotomous, resembling *Idmonea* in the angulation, at the middle of the branch, of its oblique series of peristomes (text-fig. 34, B). Zooecia exceptionally large, the low septal ridges enclosing long areas almost filled by the frontal shields,

which pass into the peristomes without angular change of direction. Pores 2. Peristomes long, tubular, conspicuously large and thick-walled; the external members of the 5 serial rows curved and strongly projecting; the orifice everted, conspicuously and variably toothed. Sinus-groove limited by strong sinus-ridges, not extending to the edge of the fully formed orifice. Primary ovicell short, delicate, later crossed by a high crater-wall (Pl. XXXVIII, fig. 26), within which the narrow median fissure remains visible; labellum uvula-like. Frontal avicularia very large, labial or lateral, greatly widened distally and sometimes bicuspid (fig. 25), Basal avicularia not found.

In view of the restricted amount of material, opercula and mandibles have not been isolated.

This very beautiful species is represented by a single fragment, 14 mm. long and 1·5 mm. wide. The zooecia are 3 serial after a bifurcation, becoming 5 serial more distally (text-fig. 34, B),

Fig. 34. — *Reteporellina idmoneoides*. — A, 112. C. Basal view. Obj. a².
B, Same slide. End of branch, with developing ovicells. Obj. A.

those of the median row being symmetrical; the *Idmonea*-like series diverging distally from the middle line of the branch at angles of about 120°.

In the young state (text-fig. 34, B) an external longitudinal fold, clearly marked off on the wall of the peristome, defines the position of the sinus-groove and sinus-ridges. These may be visible in peristomes at some distance from the growing edge, but they are later concealed within the peristome by the projection of its everted lip. An external sinus does not always occur; but, since the median line of the peristome is displaced in the marginal zooecia, it may sometimes be seen nearly at the middle of the actual inner half of the orifice, as in the outer-

most member of a transverse row of 5 zooecia (Pl. XXXVIII, fig. 26). The sinus-groove is not generally visible, as it ends with the cylindrical part of the peristome, not extending into its everted portion. Its position is commonly indicated externally by a specially prominent median proximal tooth, seen in three of the zooecia in fig. 26. This tooth is greatly thickened internally, forming a strong longitudinal ridge which passes down the peristome to one side of the sinus-groove, or fades away before it reaches it. Similar internal ridges are present in connexion with other marginal teeth, but they do not give rise to definite denticles. The marginal teeth are multiform, generally large and strong, sometimes triangular or spike-like, or forming broad expanded lobes, one of which often constitutes the morphological distal edge (fig. 26, second zooecium from left in upper row).

The large labial avicularia (fig. 25), which in this specimen are confined to the fertile zooecia, are transverse and may be strongly bicuspid. Similar avicularia may occur on the lateral margins of the branches, facing completely outwards and with a distal orientation.

An ovicell is developed, as usual, by a zooecium with a peristome deficient distally, and ending abruptly, on either side, in a high, straight or curved edge (text-fig. 34, B). It at first has the customary concave form, soon closing frontally but leaving a narrow, straight median fissure in the proximal half. It is now thin-walled, not very globose nor specially narrow proximally, slightly longer than wide but hardly as wide as the peristome, the proximal lip of which may conceal it at later stages. The labellum is small and uvula-like, with short lateral slits at its sides. The lateral flanges are flat continuations of the frontal wall of the ovicell, which becomes surrounded later by a very high crater-wall (Pl. XXXVIII, fig. 26). This is developed as a prolongation of the lateral edges of the peristome, although the adjacent zooecia doubtless contribute towards the formation of its outer lamina. The line of fusion of these secondary growths is indicated, in the avicularium-bearing zooecium of fig. 26, by a triangular emargination on the distal side of the median slit which represents the line of closure of the primary ovicell. When the process is complete, the reconstituted fertile peristome hardly differs from the ordinary ones.

The basal kenozooecia (text-fig. 34, A) are regular and biserial; the vibices weak near the growing margin, very prominent in the old state; the tubercles numerous but small.

Except in size *R. idmoneoides* resembles *Retepora pectinata* Kirkpatrick (1890, CS, p. 21, Pl. V, figs 6—6*c*), from the China Sea; and this seems to be its nearest described relative and should be placed in the same genus. *Reteporellina pectinata*, with its specially delicate and small zooecia, looks like a miniature edition of the larger species. A microscopical field which includes 4 zooecia in *R. idmoneoides* contains 8 of *R. pectinata*, which has thus about half the linear dimensions of the other. From an examination of Kirkpatrick's type-specimen (89. 8. 21. 55) in the British Museum, I find that its peristomes are practically identical in their proportions with those of *R. idmoneoides*, and that they are marked by longitudinal lines, as in *Iodictyum spicatum* (p. 555). It differs from *R. idmoneoides* in having a circlet of conspicuous linear marginal denticles (usually 10), radiating inwards; and in its small frontal avicularia, directed distally. The ovicell is small and glassy, as described by Kirkpatrick, and has a narrow frontal fissure, but I have been unable to ascertain whether a labellum is present. There is no indication of a surrounding crater-wall.

3. *Reteporellina capistrata*[1]) n. sp. (Pl. XXXV, fig. 20; Pl. XXXVIII, figs 19, 20).

Group C. Type 112. K. Stat. 156. W. of Waigeu Id, 469 M. 1 fragment.

Zoarium (Pl. XXXV, fig. 20) ramose, dichotomous, the branches slightly curved at their origin, then becoming parallel as in a tuning fork. Zooecia 2—4 serial, not forming angular transverse rows. Young zooecia delimited merely by septal lines enclosing wide and short areas entirely filled by the convex frontal shields, which pass into the peristomes with little change of direction. Pores not found. Peristomes (Pl. XXXVIII, fig. 19), most of which appear to be fertile, very thick-walled, early becoming immersed with the exception of two highly developed, projecting collar-like lips which usually constitute a bilabiate orifice. Strong internal ridges give rise to 5—7 conspicuous marginal denticles on each side. Labial pore closed, wider than long, at the frontal level between the lips of the peristome. Frontal avicularia large, triangular, acute. Ovicells globose distally, pyriform, very long, especially their vertical lateral flanges, the median fissure apparently closing but leaving a groove prolonged into the narrow labellum. A crater-wall surrounding the ovicell does not occur. Basal avicularia like those of the frontal surface.

The opercula and mandibles have not been isolated. The mandibles, as seen in a dry slide (Pl. XXXVIII, fig. 20), are highly chitinized, acute and widely triangular proximally.

R. capistrata is no less beautiful than the preceding species, with which it was found, at the remarkably productive Station 156. It is represented by a single fragment, practically in one plane, 22 mm. long, the branches with a maximum width of about 1.5 mm. The zooecia are typically biserial, but 3—4 serial before a bifurcation. The very convex frontal surface is covered, with the exception of the ovicells, by large kenozooecia. These are limited by vibices and bear small tubercles or large granules, as well as irregular projections due to peristomes or avicularia which have become partially or completely immersed. It thus appears that the greater part of the surface, including the living portions, belongs to kenozooecia, each of which bears an avicularium. Fig. 19 is from a region close to a growing end. The area A, indicated by its tuberculation (not drawn in the other areas), is a large, nearly flat kenozooecium. It is sharply outlined by septal lines or vibices, very distinct where they cross the base of a peristome or meet an ovicell. B is a similar kenozooecium. Although the boundaries of the areas probably coincide, to some extent, with those of the zooecia, the separating lines are no more than partially those which at first delimited the zooecia. Buchner (1924, UJR, pp. 185, 196) described a similar masking of the original septal lines by kenozooecia, in *Reteporella obtecta*.

Most of the peristomes (fig. 19) rise steeply, either as a simple tube deficient in the region of the labial pore, or with specially strong lips diverging on either side, reaching their highest point distally and then falling abruptly to form a distal emargination. The lips are produced into several acute marginal teeth, some of which correspond with greatly thickened, internal longitudinal ridges. At a little distance from the edge these ridges give rise to 5—7 conspicuous marginal denticles on either side.

The frontal avicularia are of one kind only; — large, mound-like swellings, most raised distally, the apex acute, decurved or with a short, upstanding beak. An avicularium occurs on

1) Collared, in allusion to the form of some of the peristomes.

every zooecium, its orientation more or less distal, the arrangement such that the middle line of the branch has a longitudinal row, directed alternately right and left.

The youngest ovicell is in the concave stage. Owing to the narrowness of its proximal part, the distal deficiency of the fertile peristome is also narrow; and most of the peristomes appear to be of this type even if they develop no ovicell. I thus regard E in fig. 19 as a fertile peristome, with a distal deficiency and diverging collar-like lobes. Others without the deficiency and with a more circular orifice are less common and represent the ordinary type. A later stage of the ovicell corresponds with C in the same figure, except that there is no trace of the labellum. It shows a longitudinal groove, in the position of that faintly indicated in C, resulting from the fusion of the two frontal halves. The lateral flanges are already developed (as in C), as nearly vertical ridges. At the next stage the labellum has a thin-walled groove of some vertical depth, and has acquired its final outline. Its basal wall is complete, but the frontal wall is deficient except laterally, where it is partially roofed, its cavity being continuous with the original longitudinal groove. In the mature ovicell (C), the distal part of the groove has remained shallow, but its proximal continuation in the labellum is so much deeper that at first sight it looks like a fissure. The frontal wall of the completed ovicell is gently concave from the distal end of the longitudinal groove to the tip of the labellum.

The basal surface has tubercles like those of the front, the young vibices being inconspicuous, but older ones are more prominent. The primary kenozooecia (not well seen) are apparently of the normal biserial type. Secondary kenozooecia cross the others, the pattern being different in the young and old parts. Avicularia are more numerous basally than frontally, the basal ones being of the same general character as the others, but being rather smaller, the proximal end immersed, rising to the distal acute end, which is raised with a small free projection. In the older parts basal avicularia are seen in various stages of immersion by the calcareous crust, ultimately becoming prominent conical tubercles much larger than the ordinary small ones.

4. *Reteporellina laxipes* (Canu and Bassler). (Pl. XXXVIII, figs 21—24).

Retepora (*Reteporella*) *laxipes* Canu and Bassler, 1929, BPR, p. 361, Pl. XLV, figs 1—12. Philippine Is., 108—530 fath.

Group C. 111. J. Stat. 156. W. of Waigeu Id, 469 M. 1 fragment.

Zoarium dichotomously dividing at small angles. Branches 2—3 serial, becoming 4—5 serial before a bifurcation. Frontal pores not found. Frontal surface porcellanous, white and granular or with numerous, very small tubercles. Peristomes cylindrical, the fertile ones with a distal emargination, deep in the longer marginal peristomes (fig. 21, left, distal), more shallow in the others; the ordinary kind complete or with a shallow emargination (fig. 24). Orifice nearly circular, slightly widened; the sinus, which is generally shallow, limited by two sinus-ridges and with about 3 marginal teeth on each side, longitudinally ridged internally. Avicularia not found on either surface. Primary ovicells (figs 21, 22) long pyriform, narrower than the peristomes, prominent distally, without a median fissure or pore. Labellum small, almost equilaterally triangular, with curved sides. Lateral flanges extending far beyond it down the peristome, uniting proximally, subvertical, inclined inwards, low distally and proximally but rising to a relatively

great height at about the middle, where they become approximate and parallel. The fertile peristome may remain deficient distally (fig. 22), but in other instances it becomes secondarily tubular (fig. 23), crossing the ovicell in such a position as to leave the highest parts of the lateral flanges inside the tube. The ovicell is soon overgrown by secondary calcification, in some cases leaving a wide median area exposed; in others becoming completely occluded and then visible only as a reduced convex projection. Basal surface with numerous, very small tubercles, the vibices moderately prominent, some of the kenozooecia with a conspicuous depressed pore.

The single fragment obtained is from the Station which produced the two immediately preceding species. Each complete branch ends in a single long and pyriform, thick-walled zooecium. The calcification is extensive, as is seen by the great thickness of the wall at the end of a fractured branch; and it covers the outer surfaces of the thick-walled peristomes. Each marginal tooth corresponds with a strong internal ridge, in the neighbourhood of the orifice; but these fade away as they descend and do not form definite marginal denticles.

I have referred 111. J to Canu and Bassler's species, the description of which is unsatisfactory, with considerable doubt. The specimen is a mere fragment, but the zoarium agrees in general appearance with their fig. 1. The prominence of the peristomes and their thick walls, as well as the abyssal locality, are in favour of my determination. Canu and Bassler found avicularia.

6. **Triphyllozoon** Canu and Bassler.

Triphyllozoon Canu and Bassler, 1917, ETCB, p. 56.
Triphyllozoon Harmer, 1933, GR, p. 621.
Retepora (pars) auctt.

Zoarium fenestrate. Ovicell (except in *T. indivisum*) with a trifoliate stigma. Peristome with a closed labial pore in most species, less often with an open sinus. Operculum generally with an indefinite proximal border. Large bicuspid avicularia commonly present. Small round and oval avicularia frequent. Basal vibices relatively few, not delimiting a completely biserial arrangement of kenozooecia.

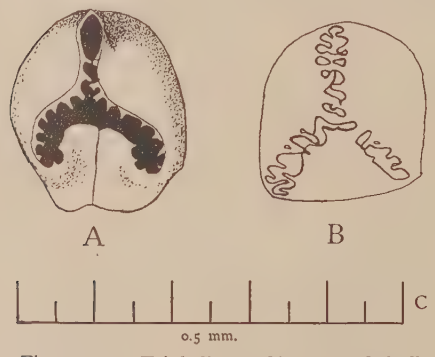

Fig. 35. — *Triphyllozoon hirsutum*. Ovicells, Obj. C. — A, 133. F^1, immature, the stigma not yet complete; B, 203. A^3, mature, decalcified, showing the pores of the stigma.

Genotype, selected by Canu and Bassler, 1917, *Retepora monilifera* MacGillivray, 1860, NCPV, p. 168, Pl. III, figs 6—9, Victoria; = *Retepora monilifera* form *monilifera* MacGillivray, 1885, PZV, Dec. X, pp. 13, 20, 23, Pl. XCVI, figs 1—2*b*; Pl. XCIV, fig. 1 (operc.).

The genus is easily recognizable by the trifoliate stigma of the ovicell, occurring constantly in all species except *T. indivisum* (p. 614) and not found in any other genus. The closure of the stigma is not yet complete in the young ovicell A (text-fig. 35). B shows the mature condition, in a decalcified specimen; the stigma being represented by a series of irregular pores. The reduced number of basal vibices (cf. text-fig. 36, p. 597) is characteristic and is in marked contrast with the biserial arrangement in *Iodictyum* and other genera. The ancestrula, as shown by *T. hirsutum*, (p. 510) is very different from that of *Iodictyum*. Canu and Bassler were mistaken in supposing that a labial pore is "apparently" always present.

So far as is known, *Triphyllozoon* occurs from the Western Pacific to the Indian Ocean, and is specially well represented off the south and east coast of Australia, in the Malay Archipelago and off Japan.

There is ample evidence that in this genus the labial pore which occurs in most of the species is developed by the union of the two sinus-lobes of an originally open sinus (text-fig. 25 B, p. 519). The sinuate condition thus appears to be ancestral, as in other Reteporidae. It is found, on the other hand, that in the sinuate species of *Triphyllozoon* the zooecia in a zone surrounding the ancestrula generally have a closed labial pore. In the central region of a colony not old enough to have this part occluded by frontal kenozooecia, it may often be seen that the more peripheral peristomes are sinuate, that in passing towards the centre zooecia can be found in which the sinus-lobes meet by their tips; the union becoming progressively more complete as the centre is approached (see p. 595). It seems to be a fair inference that although the peristome was sinuate at a remote stage in the ancestry of *Triphyllozoon*, this period was succeeded by one in which a labial pore had been evolved. The great majority of the zooecia, in a few species, have reverted, on this assumption, to the more primitive sinuate condition, while retaining evidence of their descent from forms with a closed labial pore, in the central and oldest part of the colony. These considerations should be borne in mind in connexion with the first bracket of the following key. It should further be noted that, particularly in certain species, departures from the typical condition are not rare; a sinuate peristome occurring here and there in a species which usually has a labial pore; and *vice versâ*. Specimens of *T. philippinense* (a sinuate species) from outside the Siboga area may have labial pores on practically all the peristomes.

It has been necessary to include more details in the following key than are required for other genera, in view of the fact that even the most characteristic features of a species may be completely wanting in individual colonies or parts of colonies.

Key to the species of *Triphyllozoon* here recorded.

1 { Peristome typically sinuate [1]) 2
{ Peristome typically with a closed labial pore 5

2 { Proximal wall of peristome deficient, the operculum completely exposed, the sinus specially minute, unilateral. Zoarium tubular, with internal orifices. Large avicularia frontally and basally, the rostrum wide, the mandibles with numerous long teeth at the rounded distal extremity . . . . . 4. *T. patens* n. sp.
{ Proximal wall of the peristome not deficient 3

3 { Orifices on the inner sides of the tubes and funnels. Large frontal avicularia with toothed mandibles as in *T. patens*. Infrafenestral avicularia large, widening distally, strongly cusped, the mandible bifoliate . . . . . 3. *T. tubulatum*.
{ Orifices on the outer sides of the tubes, if these are present. Avicularia of the type of *T. patens* wanting 4

1) See second paragraph on this page.

4	Zoarium tubular or cup-shaped. Spines [1]) typically numerous, long and jointed; or unjointed, often short. Frontal and fenestral avicularia bicuspid, with narrow acuminate mandibles; those of the general surface usually large and inflated, those in the fenestrae often smaller, sometimes very numerous, the rostrum symmetrical. Ovicells generally mucronate, the lateral arms of the stigma long, strongly curved	1. *T. hirsutum.*
	Zoarium widely tubular. Spines 1 : 1, thin and short. Lateral fenestral avicularia as in *T. hirsutum*. Larger infrafenestral avicularia bicuspid, descending, the rostrum curved sideways, the mandible with an asymmetrical terminal lobe. Ovicells at most submucronate, the lateral arms of the stigma short, straight or slightly curved	2. *T. philippinense.*
5	Zoarium expanding nearly in one plane. Fenestrae generally large, trabeculae narrow. Frontal avicularia large, horizontal, the rostrum and mandible widely spatulate. Ovicell not mucronate, the lateral arms of the stigma short	12. *T. patulum* n. sp.
	Large spatulate frontal avicularia wanting	6
6	Zoarium generally saucer-shaped. Large frontal avicularia usually common in the lateral margins of the fenestrae or on the general surface	7
	Zoarium more or less tubular. Large avicularia fenestral or wanting	10
7	Zoarium saucer shaped, fenestrae small. Marginal avicularia widening distally, with two very prominent cusps, the mandible strongly trifoliate. Ovicell not mucronate, its stigma median, linear, with no trace of lateral arms	8. *T. indivisum* n. sp.
	Stigma of ovicell trifoliate. Fenestrae large, trabeculae narrow	8
8	Zoarium expanding nearly in one plane. Marginal avicularia as in *T. indivisum*, the mandible unbranched but more or less widened near the distal end. Ovicells at most submucronate, the lateral arms of the stigma diverging at nearly 180°. .	9. *T. bimunitum.*
	Large frontal avicularia more or less triangular, not conspicuously widening distally, generally numerous. Ovicell not mucronate	9
9	Form of zoarium uncertain. Fertile peristomes closing to form a Cyclostome-like tube with a complete distal wall, the lateral arms of the stigma of the ovicells diverging at nearly 180°, but often largely occluded, ...	13. *T. separatum* n. sp.
	Zoarium saucer-shaped. Fertile peristomes not closed distally, the lateral arms of the stigma of the ovicells strongly curved. Munitiform frontal avicularia, sometimes large, may occur .	11. *T. tuberculiferum* n. sp.

1) In most species actual spines occur only on certain very young zooecia; but spine-bases with no free spines are frequently found on older zooecia.

Zoarium generally tubular and infundibuliform, with internal orifices. Munitiform avicularia sometimes present. Ovicells not mucronate. Mandibles of avicularia not trifoliate 11

10 Zoarium cup-shaped or tubular, with external orifices. Infrafenestral avicularia (often wanting) large, strongly bicuspid, median, projecting distally into the fenestrae, the mandible trifoliate. Munitiform avicularia wanting. Mucro of ovicell reflexed, but often obliterated by inclusion in a large, spike-like, vertical avicularium; the lateral arms of its stigma strongly curved . . . . . 7. *T. trifoliatum* n. sp.

11 Zoarium cup-shaped with wavy laminae, sometimes becoming subtubular; trabeculae narrow. Fenestral avicularia munitiform, generally suprafenestral; or large and acute, sometimes immense, greatly raised, the rostrum deflexed, its margins finely denticulate; occurring on the sides or proximal borders of the fenestrae or wanting. Large immersed basal avicularia, long and parallel-sided, not widening distally; small avicularia numerous frontally. Peristome generally cusped by the projection of the labial avicularium . . . . . 10. *T. mucronatum.*

Zoarium conspicuously tubular and infundibuliform, the fenestrae often deformed by projecting ovicells. Infrafenestral bicuspid avicularia typically present. 12

12 Tubes and funnels delicate, compact. Fenestrae very small, trabeculae generally stout. Infrafenestral avicularia short, with 2 or 3 cusps, facing the fenestra, the mandible bifid or bifoliate. Large frontal avicularia often numerous, nearly horizontal, bicuspid. Munitiform frontal avicularia rare. Large basal avicularia like the infrafenestral avicularia, widening distally, with bifoliate mandibles; or hardly widening, the mandibles acuminate. . . . . 5. *T. benemunitum.*

Tubes, funnels and fenestrae larger, the trabeculae narrower. A massive avicularium, seldom found and often wanting, proximally in a fenestra, the rostrum long, subacute, ascending, with an obliquely proximal orientation. Infrafenestral avicularia like those of *T. benemunitum* and (rare) munitiform avicularia may occur. Basal avicularia large, immersed, the rostrum long, widening distally. Avicularia other than the labial avicularia are very rare in some specimens. . . . 6. *T. inornatum*

1. *Triphyllozoon hirsutum* (Busk) (Pl. XXXV, fig. 24; Pl. XXXVI, fig. 1; Pl. XXXIX, figs 1—4) text-fig. 24, p. 510; text-fig. 25, B, p. 519; text-fig. 35, p. 590; text-fig. 36, p. 597).

Retepora hirsuta Busk, 1884, Chall., p. 119, Pl. XXVI, figs 4*a*—*g*; text-fig. 29 (operc., mand.). Torres Straits, 8 fath.

Retepora hirsuta Waters, 1909, SRS, p. 175, Pl. XVIII, figs 24—26 (25, 26, operc., mand.). Red Sea, 30 fath. Zanzibar.

Retepora hirsuta Waters, 1913, BEA, p. 523. British E. Africa, 10—20 fath.

Group A. 57. B. Stat. 80. Borneo Bank, Strait of Makassar, 40—50 M. Several.
281. A. Stat. 43. Pulu Sarassa, Postillon Is., 0—36 M. 1 col.
150. A. Stat. 204. Between Wowoni and Buton, S. E. Celebes, 75—94 M. 1 col. (?).
Group B. 467. A. Stat. 91. Muaras Reef, E. Borneo, 0—54 M. 3 young col.
89. A. Stat. 116. Kwandang Bay, N. Celebes, 72 M. 1 col.
482. A. Stat. 116. Kwandang Bay, N. Celebes, 72 M. Fragments.
470. A. Stat. 97. Sulu Archipelago; 564 M. 1 col.
Group C. 108. A. Stat. 144. S. of Halmaheira (Djilolo), 0—45 M. Many pieces.
396. Y. Stat. 162. Off Loslos Id., N. end of New Guinea, 18 M. Fragments.
121. B. Stat. 164. W. end of New Guinea, 32 M. Fragment.
133. D. Stat. 164. W. end of New Guinea, 32 M. Fragments.
133. F. Stat. 164. W. end of New Guinea, 32 M. 1 col.
297. C. Stat. 273. Jedan, Aru Is., 13 M. 2 young col.
311. A. Stat. 273. Jedan, Aru Is., 13 M. 2 very young col.
544. F. Stat. 273. Jedan, Aru Is., 13 M. 1 minute col.
193. C. Stat. 274. Off Jedan, Aru Is., 57 M. Several col.
203. A. Stat. 282. Timor, E., 0—54 M. 1 col.
204. C. Stat. 282. Timor, E., 0—54 M. Fragments.

British Museum: —

Torres Straits, 8 fath., Challenger (BUSK's type-material), 87. 12. 9. 493, 494, 495.

Cambridge, Mus. Zool.: —

Torres Straits, 8 fath. Challenger Coll., paratype of *R. hirsuta*. Reg. Nov. 18, 1899.
Torres Straits, A. C. HADDON Coll. 18, 24, 94. Reg. Feb. 24, 1898; and 216, Reg. May 26, 1900.
Singapore, 5—18 fath. F. P. BEDFORD Coll., 1, 2, 3, 5. Reg. Nov. 11, 1899.
BM Singapore, 6 fath. R. HANITSCH Coll., A. Reg. Apr. 10, 1900.
Singapore, from a submarine cable. C. STEWART Coll., 1, 2. Reg. Apr. 26, 1899.

All the specimens are from shallow water, except 470. A, Stat. 97, 564 M. This locality is not far from land, and the colony may perhaps have been drifted from shallow water.

Zoarium either retaining the primitive cup-shaped form and produced into wide wavy lamellae which do not anastomose (Pl. XXXV, fig. 24), or with lobes bending backwards and uniting by their basal surfaces to produce tubes and funnels bearing external orifices. Fenestrae generally small, oval (occasionally larger), sometimes deformed by projecting ovicells, the trabeculae mainly 2—3 serial. Peristome typically with a large sinus, constricted at its junction with the secondary orifice, but sometimes small; a closed labial pore occurring in the zooecia of the initial stages of the colony and occasionally in younger zooecia (text-fig. 25 B, p. 519). Spines 3 : 3 in very young colonies; usually 1 : 1 or 1 : 2 in some of the marginal zooecia; long, jointed and often antenniform or small, thin and unjointed. Actual spines, as distinguished from mere spine-bases, are more common than in other species. Labial avicularia generally rare, minute; the

rostrum and mandible rounded or occasionally acute. Frontal and fenestral avicularia bicuspid; on the general surface usually inflated, large, more or less horizontal, with a freely projecting rostrum; in the fenestrae commonly small; — all with a simple acuminate mandible. Avicularia with bifid mandibles wanting. Ovicells sharply mucronate, submucronate or without a mucro; the lateral arms of the stigma strongly curved, generally longer than the median arm. Decalcified ovicells (text-fig. 35 B, p. 590) retain their outline better than in most other species, probably owing to the presence of an unusual amount of chitin; and the details of the pores of the stigma are well shown in such specimens. Basal surface (text-fig. 36, p. 597) with few vibices, which are mainly longitudinal; often bearing large, more or less bicuspid avicularia, usually immersed, but swollen in the young condition and closely resembling those of the other surface. Small avicularia on the general surface, as well as in the margins of the fenestrae, basally.

T. hirsutum, as I understand it, is a variable species, the extreme forms of which are very different from one another. It is most easily recognized by the large inflated bicuspid avicularia of both surfaces and by the similar avicularia, usually smaller, which may occur in profusion in the fenestrae, invariably with simple mandibles (cf. Waters, 1913, p. 524). Both kinds have been found in most of the specimens here described, though sometimes in extremely restricted numbers; and one kind or the other has been found in all except the very youngest colonies.

The zoarium varies in colour (white or pinkish, as preserved in spirit), even at the same locality, as shown by specimens from Singapore (Stewart Coll.). Its early growth and the characters of the ancestrula are described above (p. 510). The cup-shaped form typical of most Retepores in their young condition may persist without much modification (Pl. XXXV, fig. 24). In many others the growth becomes tubular and infundibuliform, its shape probably depending to some extent on the nature of the substratum. In 57. B, a colony 32 mm. in diameter, growing on a delicate Alcyonarian axis, the central region early became flat, instead of concave. The lobes of its peripheral expansions grew in a basal direction, uniting back to back so as to form tubes with external orifices. Torres Straits 216 has a similar general form, but the lobes have become extremely wavy without much anastomosis, and it has almost encircled the delicate axis of a Plumularian Hydroid on which it was growing. It is obvious that the growth of a colony on a flat substratum cannot extend backwards beyond the plane of its base of attachment. The habit of the colony, in this species, is usually delicate, with small oval fenestrae, but in 89. A and 150. A the fenestrae are much wider than the narrow trabeculae.

The frontal surface is generally at first tubercular, becoming nearly smooth by later calcification. Pores are more conspicuous than in most of the other species; a pair commonly occurring on the proximal side of the peristome and another pair at the extreme proximal end of the zooecium (cf. Waters, 1909, Pl. XVIII, fig. 24).

The primary orifice (Pl. XXXIX, fig. 3) has a minute asymmetrical sinus; — a feature which seems to be usual in Retepores. The young peristome is well raised laterally and to some extent proximally, where it is interrupted by the sinus, if this is present. As in *T. tubulatum*, another species in which the more primitive labial pore commonly remains as an open sinus, the zooecia of the initial stages of the colony almost always have a relatively small labial pore. This generally shows a progressive increase in size, in proportion to its distance from the centre of the colony, until a condition is reached where two large, triangular "sinus-lobes" just meet by

their tips (text-fig. 25 B, p. 519). With the separation of the tips, in other zooecia, a large open sinus results (Pl. XXXIX, fig. 2), consisting of a proximal circular part which may be almost as large as the secondary orifice, and of its narrower communication with the orifice. This is best shown in the specimens from Torres Straits, Singapore and Group C of the Siboga Stations. In other instances the sinus may be triangular, widest distally, or small and narrow with little resemblance to its typical form; and in a few cases a closed labial pore is found even in zooecia far removed from the centre. The peristome has an even margin in the older zooecia, with no proximal cusp formed by a labial avicularium, a structure which is generally restricted to a small number of the zooecia. These avicularia are generally of the customary small round type, but they are occasionally long, narrow and bicuspid (Pl. XXXIX, fig. 2), with acute mandibles (fig. 4, *h*); *e* in the latter figure representing a round mandible from the same colony as *h*. Acute labial avicularia were found in Busk's type-material, in 193. C and 297. C and in Torres Straits 216.

The specimens from Torres Straits (the type locality) and the W. end of New Guinea agree closely with Busk's description. The specific name applies well to these, many of them being profusely covered by long jointed spines, which give them a hairy appearance. The full number, in the youngest colonies, is 3 : 3, although Busk figured no more than 5. This condition does not last long, and subsequent zooecia show a rapid falling off in the number, which soon becomes 1 : 1, or 1 : 2 in some marginal zooecia; the extra spine being on the outer side. By a dilatation of each segment the spine may become antenniform (text-fig. 24, p. 510); and such spines are as a rule notably thicker than others which are either unjointed or have segments not widening distally. Although both spines of a zooecium may be antenniform it is a curious fact, which I have noticed in other species, that a spine of this conformation is frequently restricted to the inner side of a peristome, the outer spine being short, thin and unjointed. Antenniform spines have been found in all the specimens from Torres Straits, in most of those from Group C of the Siboga Stations and in one or two from Singapore; but in none of those from Groups A and B. In these last, however, the spines may be jointed and a spine-base may generally be found on each side of the orifice in some of the zooecia. The typical *hirsuta* condition of the spines is wanting, however, in these specimens.

The number of avicularia is highly variable. In the typical condition, as described by Busk, the frontal margins of a fenestra are provided with small, narrow, descending bicuspid avicularia, several of which occur on each side. These are numerous in specimens from Torres Straits, less numerous in those from Singapore, and variable in number in the Siboga specimens. In those from the Aru Is (Pl. XXXIX, fig. 1) and in others, they are numerous; but they may be extremely rare and they were not found in 482. A, nor in specimens so young as not to have developed fenestrae. In some instances they are specially large. Their orientation is proximal, facing the fenestra, and they are commonly longitudinal, not descending.

The large inflated frontal avicularia may occur on some of the initial zooecia (Torres Straits, 18), and are numerous, though varying in size, in parts of other specimens. In some instances they are rare and they were not found in a few colonies all of which have bicuspid fenestral avicularia, except 482. A, in which large inflated avicularia are present on the basal surface.

Small frontal avicularia may be rare, but they are exceptionally numerous in 150. A. One or two of the oval kind can generally be found in the margins of the fenestrae, where small frontal avicularia (apparently round) commonly form small conical projections.

The ovicell often has a sharp mucro, more or less reflexed, but this may be wanting or represented merely by a slight projection of the region of the distal end of the stigma. Text-fig. 35 A (p. 590) shows a young ovicell in which the stigma is not yet fully closed; and B is a mature, decalcified ovicell in which the stigma is represented by a series of pores of irregular size. The lateral arms of the stigma (Pl. XXXIX, fig. 1) are strongly curved, as in *T. trifoliatum* (p. 611). Round avicularia are common on the ovicells, as in various other species; and an ovicell often bears a symmetrically placed pair.

The basal surface (text-fig. 36) has a specially large number of crowded small tubercles, in the young condition; becoming smooth later; the vibices being generally thin and not very strong. Large avicularia may occur, although they are generally wanting. They are specially long and narrow in 57. B, but they are usually smaller, the sides of the narrow rostrum nearly parallel or more commonly diminishing in width to the distal end, which is generally slightly widened when distinct cusps are present (text-fig. 36). The usual occurrence of small avicularia on the general basal surface, as well as on its fenestral margins, is a noteworthy feature.

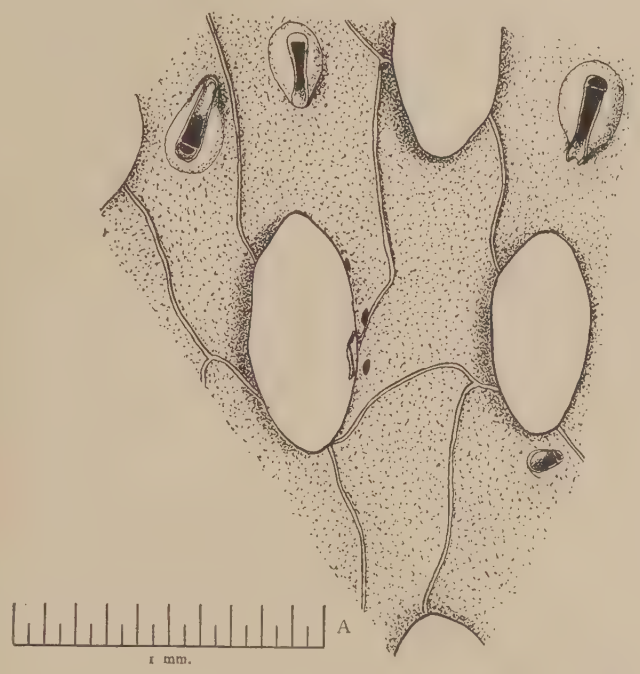

Fig. 36. — *Triphyllozoon hirsutum*. — 133. F1. Basal surface. Obj. A. Small avicularia are not common in this specimen.

The opercula (Pl. XXXIX, fig. 4, *a*, *b*) vary in outline and are sometimes slightly longer than wide. The sides may be nearly straight, converging slightly towards the distal end; but the lateral and distal outlines often form a regular curve. The marginal sclerite is generally strong, but is occasionally less pronounced. The frontal mandibles figured (fig. 4) are of the following kinds; — (1) large, very acute (*i*, *j*, *k*), narrow, usually slightly widened in the distal half; (2) marginal or fenestral (*f*, *g*), of the same general type, but usually smaller; (3) wider and shorter acute (*l*); (4) labial, generally round (*e*) but less often acute (*h*); (5) small round (*c*, *d*), semicircular or less than a semicircle, wider than long. The acute mandibles vary in frequency and size; and similar ones may occur basally, as in 57. B, in which they are longer than any found on the frontal surface.

2. *Triphyllozoon philippinense* (Busk). Pl. XXXV, figs 27, 28; Pl. XXXIX, figs 5—9)

Retepora philippinensis Busk, 1884, Chall., p. 123, Pl. XXVII, figs 5, 5*a*. Philippine Is., 10—20 fath.

Group B. 61. A. Stat. 99. N. Ubian, Sulu Archipelago, 15—23 M. 1 col.
65. A. Stat. 99. N. Ubian, Sulu Archipelago, 15—23 M. 2 fragments.

Group B. 67. G. Stat. 99. N. Ubian, Sulu Archipelago, 15—23 M. 2 young col.
671. A. Stat. 99. N. Ubian, Sulu Archipelago, 15—23 M. 1 col.

British Museum: —

Philippine Is., Challenger Coll., 87. 12. 9. 505 (BUSK's type).
Bass Strait, F. M. RAYNER. 62. 2. 4. 1. Fragment.
History not recorded. 32. 4. 22. 1 (probably the larger part of 62. 2. 4. 1).
West Australia. Capt. BECKETT, 86. 2. 19. 1.

Zoarium (Pl. XXXV, figs 27, 28) at least 50 mm. across, tubular and infundibuliform, the orifices on the outer surfaces of the tubes. Fenestrae small, oval, generally narrower than the stout pluriserial trabeculae. Peristomes usually sinuate, but often with a closed labial pore[1]); well raised proximally and laterally. Spines usually 1 : 1, thin and short. Infrafenestral avicularia more or less descending, the rostrum curved sideways and ending in two prominent cusps. Labial avicularium slightly projecting, if present. Large avicularia other than the fenestral ones very rare. Small round avicularia common frontally, especially on or among the ovicells; and basally, where they form conical projections into the fenestrae. Small oval avicularia less common, most frequent basally, in the margins of the fenestrae. Ovicells often confluent in diagonal rows, flat in front, raised distally, not definitely mucronate but sometimes submucronate by the projection of the distal end of the stigma, the wide arms of which may be subequal or the median arm the shortest; the lateral arms nearly straight or more frequently curved inwards.

The Siboga specimens are all from Stat. 99, which is sufficiently near the type-locality. BUSK's material consisted merely of a single tube, 16 mm. long, and he emphasized the fact that the orifices are on the outer side; — a character which I find to be important in distinguishing species of this genus. The ovicells of the type are numerous and are arranged in diagonal rows, as in the Siboga specimens (Pl. XXXIX, fig. 6) and in the others in the British Museum. BUSK had very imperfectly understood their character, as he did not notice the median arm of the stigma, which is clearly visible in his specimen; the "three or four punctures" which he described and figured representing all he saw of the lateral arms. The "apparently complete absence of avicularia" is not confirmed by his specimen, in which large infrafenestral bicuspid avicularia, similar to those of the Siboga material, are not uncommon.

The infrafenestral avicularia (Pl. XXXIX, figs 5, 9) appear to constitute the most distinctive feature of the species. They are swollen but not very long, and they descend more or less steeply into the fenestrae, sometimes so much that their two strong cusps are almost at the level of the basal surface and are easily seen in basal view. Two such avicularia may occur in the same fenestra (65. A). The rostrum, which becomes slightly wider distally, appears curved sideways, a feature I have not observed in any other species of the genus. The asymmetrical mandible (see below) has a distinctive form.

The examination of the type-specimen, with confirmation afforded by the Siboga material, has suggested that the peculiar infrafenestral avicularium may be a modification of the type found in *T. tubulatum*. In that species (Pl. XXXIX, fig. 15) the rostrum widens considerably at its distal end, which is slightly bifid, each division having two cusps. The rostrum is thus 4-cusped, two of the projections lying near the basal surface and two near the frontal surface.

1) The peristomes have labial pores in the British Museum specimens from Bass Strait and W. Australia.

Its bifoliate mandible closes in such a way that one of its lobes lies between the basal cusps, and the other between the frontal cusps. Avicularia of this type may lose one of the frontal cusps and are then tricuspid; but owing to the way in which they are frequently hidden in the fenestra it is not always possible to decide whether they are tri- or quadri-cuspid. In *T. philippinense* the cusps of the rostrum (fig. 5) are fewer and the frontal one is sometimes vestigial or hardly visible. The asymmetry of the mandible may indicate that the frontal leaf of a bifoliate mandible has been suppressed, since the subterminal lobe seen in fig. 8 (*k*, *l*) belongs to the basal edge.

Large avicularia other than the infrafenestral ones are very rare, but in 61. A a single large frontal avicularium projects transversely into a fenestra, near its distal end. Its rostrum is emarginate at the widened extremity, and each of the two lobes thus formed has two slight points, one at either margin. Munitiform avicularia have been found rarely (Pl. XXXIX, fig. 8, *d*, mandible). Small round avicularia are common among the ovicells.

The young zooecia (Pl. XXXIX, fig. 9) are relatively broad, moderately convex and smooth, the surface later becoming tubercular. They are outlined by thin septal lines hardly prominent enough to give rise to marginal valleys, and they may have 2 or 3 marginal pores, commonly on one side only, remaining distinct in the older state. The primary orifice has an asymmetrical lyrula (as in other Retepores), at one end of which is a minute sinus. When the peristome begins to develop, its sinus (fig. 7) is traceable as a groove into the primary sinus; and it may be assumed that it there becomes continuous with a compensation-sac. The two lobes bounding the peristomial sinus are high and curved and they often end in triangular points which approach one another, so that the sinus is narrower distally than proximally (fig. 6); but the sinus varies in form and size and may be large and wide (fig. 5). The labial avicularium, rarely present, is small and rounded, not forming an appreciable cusp on the peristome. The spines are usually short, and none of the antenniform type have been found. Although usually a single pair, 2 : 3 (the larger number external) have been found in the young colony 67. G; and in this specimen, as in 671. A, most of the peristomes have a closed labial pore (fig. 9), often of large size; the closed condition being occasionally found in other colonies. This variability is in accordance with *T. hirsutum*, another typically sinuate species in with the young colonies have labial pores centrally and (if they are old enough) sinuate peristomes peripherally.

The basal surface is tubercular, the vibices mostly longitudinal or oblique, prominent but narrow in moderately old parts, resembling those of *T. hirsutum* (text-fig. 36, p. 597). Large basal avicularia are wanting, a respect in which this species differs from *T. hirsutum*. Small avicularia, round and oval, occur on this surface, principally in the margins of the fenestrae.

The opercula (fig. 8, *a*, *c*) are longer than in *T. hirsutum*, more regularly rounded and have a more delicate sclerite. Mandibles of the following kinds are figured; — (1) large, very acute, asymmetrical, possibly frontal (*i*); (2) asymmetrical, infrafenestral (*k*, *l*) in which the terminal lobe is reflexed so as to overlap the rest of the mandible. This lobe, which has been found in 61. A, 65. A and 671. A, is extremely delicate and hyaline, sharply marked off from the more chitinized remainder of the mandible. It arises from the basal edge, being generally given off laterally but sometimes more nearly terminally; (3) similar mandibles (*j*) in which the

lobe is not reflexed; most of the large frontal mandibles of 61. A being of this type; (4) labial (*b*); (5) small round frontal (*d—f*), *d* being munitiform, well chitinized and with a specially large occlusor muscle; (6) small round basal (*h*) and oval (*g*) of the same surface. The distal margin of a round mandible may be minutely denticulate, as in certain other species.

The British Museum Collection includes four specimens probably referable to this species. Of these, 32. 4. 22. 1 had been found without a label; but from internal evidence it is almost certainly the colony from which the fragment 62. 2. 4. 1 was broken off. The latter is recorded as from Bass Straits, a locality which has surprised me. Both specimens have ovicells in diagonal rows and in extraordinary profusion; — so far as I could see, every zooecium being thus provided. Small round avicularia are specially numerous, 1—3 occurring on most of the ovicells. All the colonies (dry) are more or less pink, convoluted, with some tendency to produce closed tubes and funnels with external orifices. They agree with the Siboga specimens in having large infrafenestral (frontal) avicularia, the rostrum widening greatly distally. It is here somewhat bilobed, the basal lobe with two well marked cusps, which are evanescent or wanting in the frontal lobe. The peristomes have closed labial pores, a character which is found in two of the Siboga specimens. One of these, 67. G, is very young, a significant fact in view of what has been pointed out above (p. 595), under *T. hirsutum*. The small fenestrae, the stout trabeculae and the ovicells agree well with the corresponding parts of Siboga specimens.

3. *Triphyllozoon tubulatum* (Busk). Pl. XXXV, fig. 30; Pl. XXXIX, figs 10—15).

? *Reticulum marinum* Rumphius, 1750 (see above, p. 538). Amboina.
Retepora tubulata (pars) Busk, 1884, Chall., p. 121, text-fig. 32 (operc., mand.) (nec Pl. XXVIII, figs 2—2*b*). Torres Straits, 8 fath.
Retepora tubulata Thornely, 1905, PGM, p. 125 (no description). Gulf of Manaar (Ceylon).
Retepora tubulata Hastings, 1932, PGBR, p. 442, text-fig. 18 A—E (operc. mand.). Torres Straits, from Busk's slide 82. 7. 29. 99; text-fig. 18 F, Great Barrier Reef.
Retepora monilifera, var. *benemunita* (pars), Hastings, ibid., p. 441.
? *Retepora tubulata* MacGillivray, 1887, PRSV, XXIII, p. 184, Gaspar Strait (E. of Sumatra), 17 fath.
? *Retepora tubulata* Thornely, 1907, MPIM, p. 193. Gaspar Strait; Strait of Malacca; India, E.
? *Retepora tubulata*, var. Waters, 1913, BEA, p. 526. British E. Africa and Zanzibar, 10 fath.

The last three records were given with inadequate descriptions or none. Miss Thornely (1907) and Waters stated that that while the orifices were generally internal, they were sometimes on the outer surface of a tube or funnel.

Group A. 556. C. Stat. 322. Bawean Id., Java Sea, 32 M. 1 young col. and fragment.
9. C. Stat. 33. Pidjot Bay, Lombok, 0—22 M. Fragments.
336. C. Stat. 37. Sailus Ketjil, Paternoster Is., 0—27 M. Several, young.
13. A. Stat. 38. Paternoster Is., 521 M. 1 col.
337. C. Stat. 71. Makassar, S. W. Celebes, 0—32 M. Several.
378. F. Stat. 71. Makassar, S. W. Celebes, 0—32 M. Fragments.
317. A, C. Stat. 50. Bay of Badjo, W. Flores, 0—40 M. Several.
602. A. Stat. 50. Bay of Badjo, W. Flores, 0—40 M. Several.
446. A. Stat. 59. Samau Strait, W. Timor, 390 M. Fragments.
Group C. 396. D. Stat. 162. Off Loslos Is., N. end of New Guinea, 18 M. Several.
133. B. Stat. 164. W. of N. end of New Guinea, 32 M. Several.
660. A. Stat. 164. W. of N. end of New Guinea, 32 M. 1 young col.

Group C. 297. B. Stat. 273. Jedan, Aru Is., 13 M. Several pieces.
193. F. Stat. 274. Off Jedan, Aru Is., 57 M. Fragment.
195. H. Stat. 274. Off Jedan, Aru Is., 57 M. Fragment.

British Museum: —

The majority of the specimens from the 'Challenger' Collection, Torres Straits, 8 fath., described by Busk as *Retepora tubulata*, as follows: —

82. 7. 29. 99 (slide, operc., mand.).
87. 12. 9. 502; the larger of two colonies.
99. 7. 1. 3171, 3174, 3175, 3177, 3181 and others.

(For the remainder of Busk's material, see *T. benemunitum*, p. 606).

Cambridge, Mus. Zool.: —

Torres Straits, Challenger Coll. (paratype). Reg. Nov. 18, 1899.
Torres Straits, A. C. Haddon Coll., 93. Reg. Feb. 24, 1898.
Torres Straits, 10—20 fath., A. C. Haddon Coll. 225. Reg. May 26, 1900.
Singapore, 5—10 fath. F. P. Bedford Coll., 4. Reg. Nov. 11, 1899.
Singapore, 6 fath. R. Hanitsch Coll., B. Reg. Apr. 10, 1900.
Ceylon, Miss L. R. Thornely, 63, Reg. Apr. 25, 1906.

As indicated by these records, *T. tubulatum* has been obtained from Torres Straits (the type-locality), the W.end of New Guinea, the southern Malay Is, Singapore, Ceylon and possibly from British E. Africa. All are from shallow water except 13. A (521 M.) and 446. A (390 M.).

Zoarium (Pl. XXXV, fig. 30) tubular, the tubes and funnels delicate and small, the orifices (with rare exceptions) on the inner surfaces. Fenestrae usually small, oval, less often deformed by projecting ovicells than in *T. benemunitum*; the trabeculae stout and 2—4 serial. Peristome typically with a conspicuous sinus, but in some instances, specially in young colonies or in the central parts of older colonies, with a closed, small labial pore. Labial avicularium, often wanting, submedian or lateral, seldom projecting as a distinct cusp. Spines 1 : 1, thin, sometimes long, usually represented merely by their bases. Infrafenestral avicularia large, with 2—4 cusps, facing the fenestra or obliquely frontally, conspicuously widening distally, the mandible broad at the origin of its two long free lobes. Large frontal avicularia raised, the wide rounded rostrum rising to the summit, the mandible with long teeth distally. Munitiform avicularia not found. Ovicells delicate, not mucronate. Basal vibices weak; large avicularia, not common on this surface, immersed, obscurely trifid distally, the mandibles like those of the infrafenestral avicularia.

The features by which *T. tubulatum* can most easily be recognised are the characteristic large frontal avicularia (Pl. XXXIX, figs 14, 15), their mandibles with long teeth (figs 10 *b*, 12), and the cusped infrafenestral avicularia (fig. 15) with markedly bifoliate mandibles (fig. 10 *e*), wide at the origin of the two leaves.

The recognition of this species gave me great difficulty until I obtained convincing evidence, by the study of the original material in the British Museum, that Busk had included under *Retepora tubulata* two species which I indicate below as "A" and "B". Both are well represented in the Siboga Collection.

Busk's figures 2—2 *b* (Pl. XXVIII), showing the zoarial and zooecial characters, refer to A; and his text-fig. 32 (operculum and mandibles) to B. Better figures of these chitinous parts of the type-specimen, substantially agreeing with Busk's, have been given by Miss Hastings

(1932, text-fig. 18 A—E, p. 443). The selection of the type-specimen of *R. tubulata* is thus important; and Miss HASTINGS and I are agreed that this should be the larger (B) of two colonies registered as 87. 12. 9. 502. BUSK's slide 82. 7. 29. 99 was evidently prepared from that colony, and it is the original of the text-figures of both BUSK and Miss HASTINGS. The advantage of making this selection is that BUSK's text-figure has no doubt enabled earlier workers to recognize species B, whereas the figures in his Plate insufficiently distinguish A from certain other species.

The differences between the two species may be shortly indicated as follows: —

B. *Triphyllozoon tubulatum* s. str. — Peristome typically (but not invariably) with an open sinus. Infrafenestral mandibles widely bifoliate. Large frontal avicularia not bicuspid, raised distally, the mandibles wide, relatively short, with long teeth distally.

A. *Triphyllozoon benemunitum* (see p. 605). — Peristome with a labial pore. Infrafenestral avicularia with bifid mandibles, not so wide distally as in B, the two branches shorter. Large frontal avicularia bicuspid, horizontal, the mandibles acute.

With one exception (602. A, growing on a delicate Alcyonarian axis), all colonies not in their initial saucer-shaped condition or represented merely by fragments have the peristomial orifices on the inner sides of the tubes or funnels. In 602. A the usual initial cup is represented by a central dimple, the zoarium then becoming slightly convex frontally, the edges of its expansion bending backwards and forming lobes which have united, back to back, thus producing a few funnels with external orifices.

The peristome is more variable than in most other species. In the majority of cases this part is conspicuously sinuate (fig. 14), zooecia with a closed labial pore being rare. In a few specimens these conditions are reversed, but at least two of them are young colonies. 337. C is specially instructive in this respect (cf. p. 595), the more central zooecia having a closed pore, and the more peripheral ones an open sinus. Normal small labial avicularia are apparently wanting in many colonies; or, if present (fig. 15), they may occur in a small proportion of the zooecia. When present, they seem to be invariably on zooecia which do not possess one of the characteristic frontal avicularia. These are to be regarded, I think, as modified labial avicularia. They vary much in size, some being hardly larger than an ordinary labial avicularium; an enlargement of which and of the minute teeth they normally possess, with a slight displacement, would convert them into the more frontally situated raised avicularia. These (fig. 15) were found in all except 317. C; but 317. A from the same Station possesses them. A larger avicularium of this type is sometimes suprafenestral. Their remarkable toothed mandibles (figs 10*b*, 12) distinguish *T. tubulatum* from all other species except *T. patens* and its near allies or possible synonyms (see pp. 604, 605).

The large cusped infrafenestral avicularia (fig. 15) have been found in all the Siboga specimens, sometimes in a considerable proportion of the fenestrae, in other instances more sparingly. They widen greatly to their distal end, in correlation with the distant leaves of the bifoliate mandible (fig. 10*e*). The number of cusps is from 2 to 4; the most constantly present, and generally the strongest, being the two which belong to the more basally situated lobe of the rostrum. The frontal lobe may be without cusps, or may have a single cusp, usually on the outer side and often inconspicuous. The occurrence of two definite frontal cusps is unusual. The two leaves of the mandible close in the two lobes of the rostrum.

Small avicularia are variable in their occurrence and are sometimes hardly to be found on the frontal surface, where a few of the oval type are most often present in the margins of the fenestrae. As in many other Retepores, small round avicularia may be common on or among the ovicells.

The ovicells (fig. 15) are not mucronate. The arms of the stigma are subequal, the lateral arms nearly straight, diverging at almost 180° and often slightly dilated at their free extremities. In some colonies the ovicells become confluent, by secondary calcification, in diagonal rows.

The basal surface is strongly tubercular in certain stages of growth and is traversed by a few thin or moderate vibices, arranged as in *T. hirsutum*, which is shown in text-fig. 36 (p. 597). It may be well provided with large immersed avicularia (Pl. XXXIX, fig. 13), which have been found in most of the specimens, but usually in restricted numbers. The rostrum widens distally, becoming obscurely tricuspid, with a median and two lateral points or rounded lobes. The mandible (fig. 11 *b*) may be hardly distinguishable from those of the frontal infrafenestral avicularia, its two leaves closing in the intervals between the cusps. Oval avicularia are generally to be found in the margins of the fenestrae, less often on the basal surface; and they are rather larger than in most other species of the genus.

It is noteworthy that decalcified preparations of this species show body-cavities more completely filled by the polypides than in most others. The opercula (fig. 10 *a*) are evenly rounded, generally with a weak marginal sclerite, and are smaller than in *T. philippinense*. The mandibles figured are (1) large toothed frontal (*b*), specially characteristic of this species and of *T. patens*: the teeth are long, as shown by the end view, fig. 12; (2) small round frontal (*f*), in which a minute denticulation is often visible; (3) delicate oval mandibles (*c*, *d*), one specially long, from the margin of a fenestra; (4) bifoliate infrafenestral (*e*), another of the distinctive features of the species; (5) two basal mandibles (fig. 11), each of the corresponding avicularia being on the proximal margin of a fenestra, the rostrum directed longitudinally away from it; so that the mandible, opened 180° from its closed position, projects into the fenestra. One mandible (*b*) is strongly bifoliate, the other (*a*) showing a distal widening suggesting that the two lobes have been suppressed. As has been noticed in other species, the large basal avicularia and their mandibles are considerably larger than the corresponding structures of the frontal surface.

4. *Triphyllozoon patens* [1]) n. sp. (Pl. XXXV, fig. 31; Pl. XXXIX, figs 16—19; text-fig. 37).

Cambridge, Mus. Zool.: —

BM Type. Torres Straits. A. C. HADDON Coll., 19. Reg. Feb. 24, 1898.
Torres Straits. A. C. HADDON Coll., 215. Reg. May 26, 1900.

British Museum: —

N. E. Australia. J. BRACEBRIDGE WILSON Coll. 97. 5. 1. 1057.

Zoarium (Pl. XXXV, fig. 31) tubular, resembling that of *T. tubulatum*, the orifices on the inner surfaces. Fenestrae small, oval, the trabeculae usually 3—4 serial. Peristomes reduced to their lateral portions, which are so slightly represented that the operculum is completely

1) In allusion to the open peristomial orifice.

visible in frontal view; the sinus minute, not median. Small labial avicularia rarely present. Spines as in *T. tubulatum*. Frontal avicularia large, rather more massive than in that species, mostly suprafenestral, but also on the general surface of the trabeculae; the rostrum raised, the mandible with long teeth at its rounded extremity. Avicularia of the same type and with similar mandibles common basally, at the proximal margins of the fenestrae, the rostrum sometimes bicuspid. Cusped avicularia with bifoliate mandibles not found frontally and infrafenestrally, but occurring, immersed, on the general basal surface, where they are tricuspid. The vibices of this surface are generally stronger than in *T. tubulatum*. Ovicells rather small, not mucronate.

T. patens may be a variety of *T. tubulatum*, with which it was found; but the exceptionally open peristomial orifice seems to justify its separation from that species. In this character it resembles *Triphyllozoon formosum* (*Retepora formosa* MacGillivray, 1884, PRSV, XX, p. 109), but the two species are in other respects very different. A slide from N. E. Australia, in the British Museum, may be referred to *T. patens*.

The zooecia are relatively wide and short, and 2—3 distinct marginal pores may occur on either side. The proximal border of the primary orifice (Pl. XXXIX, fig. 16) includes an oblique median tooth or lyrula, outside the operculum, rising continuously from one side, extending beyond the middle line and ending abruptly on the other side, in such a way as to form a minute unilateral sinus; — an arrangement commonly found in other Retepores. In many of these the primary sinus is continued by the upgrowth of the peristomial wall as a sinus-groove leading to the sinus of the secondary orifice, or closing to form a labial tube which opens by the labial pore (cf. text-fig. 25, F, p. 519). Neither of these alterations takes place in *T. patens*, in which the growth of the peristome is so slight that it is hardly possible to recognize a secondary orifice. The spines, usually 1 : 1, may be long, slender and jointed, but not antenniform.

Fig. 37. *Triphyllozoon patens*. — Mus. Cambridge, Torres Straits 19[1]. Basal surface; *a*, large raised avicularium; *b*, immersed cusped avicularium. Obj. A.

The large frontal avicularia (Pl. XXXIX, fig. 17) form massive subconical elevations, the rostrum sloping up to its rounded end and facing distally. Many occupy the suprafenestral position, but some occur on zooecia not having this relation to a fenestra. As in *T. tubulatum*, they appear to be modified labial avicularia, which are excessively rare in their ordinary minute condition. Small round avicularia may be found frontally, but not commonly except among the ovicells, where they are more frequent.

The ovicells (fig. 16) are small and short, not mucronate, the median arm of the stigma sometimes much reduced, the lateral arms short, nearly straight, diverging at rather less than 180° and often dilated at their ends.

The basal surface (text-fig. 37) shows raised infrafenestral avicularia (*a*) resembling the large frontal avicularia and probably to be regarded as enlarged round avicularia. Immersed and cusped avicularia (*b*) are less frequent, in general agreeing with the large frontal infrafenestral

avicularia of *T. tubulatum*. Small oval avicularia are common basally, principally in the margins of the fenestrae.

The opercula (Pl. XXXIX, fig. 19, *b*) and large frontal mandibles (fig. 18; fig. 19, *a*, *c*) agree closely with those of *T. tubulatum*, but the mandibles are rather larger than in that species.

I have considered the possibility that *T. patens* may be a form of *Triphyllozoon columniferum* (*Retepora columnifera* Busk, 1884, Chall., p. 122), at present known solely from the original 'Challenger' material (New Guinea, 49 fath.). The suprafenestral avicularia of Busk's species are extraordinarily long, subvertical calcareous columns. *T. patens* has large avicularia in a corresponding position, but not definitely cylindrical; and, as shown by Busk's text-fig. 33, the toothed mandibles of the two species are indistinguishable. The peristome of *T. columniferum* is well developed proximally and has a small labial pore near its edge, or a small open sinus; — in either case situated medianly. Avicularia with conspicuously bifoliate mandibles are present in many of the fenestrae, frontally; but I have found no large basal infrafenestral avicularia. The two species are clearly allied; but the differences, particularly in the peristomes, seem to indicate that they are not identical. Miss Hastings has suggested (1932, p. 444) that *T. columniferum* and *T. tubulatum* may be synonymous, but I think they are distinct. She has pointed out (p. 450) that the "parenchymatous cords" on which Waters (1888, Chall., pp. 2, 21) based certain improbable speculations, belong to an intrusive Gymnoblastic Hydroid. This or a similar species is very common on many of the specimens of *Triphyllozoon* described in the present Report (see p. 530).

Triphyllozoon delicatulum (*Retepora delicatula* Busk, 1884, p. 124 is probably a synonym of *T. columniferum*, obtained at the same 'Challenger' Station. Busk's type-slide of *R. delicatula* (Brit. Mus., 87. 12. 9. 508) has large, subcolumnar suprafenestral avicularia and infrafenestral avicularia with bifoliate mandibles. It is small, delicate and vitreous, the labial pore is generally closed, and the spines are long and numerous, usually 2 : 2; — all characters which point to a young condition. I have little doubt that it is a youthful stage of *T. columniferum*; and I have, moreover, been unable to find the "inconspicuous" ovicells mentioned by Busk. Miss Robertson's record (1921, BBB, p. 59), without description, of *Retepora delicatula* from the Bay of Bengal may be considered doubtful.

5. *Triphyllozoon benemunitum* nom. nov. (Pl. XXXV, figs 25, 26; Pl. XXXIX, figs 20—26; text-fig. 28, p. 530).

? *Reticulum marinum* Rumphius, 1750 (see above, p. 538). Amboina.
Retepora tubulata (pars) Busk, 1884, Chall., p. 121, Pl. XXVIII, figs 2—2*b* (nec text-fig. 32, p. 122). Torres Straits. 8 fath.
Retepora monilifera var. *benemunita* (pars), Hastings, 1932, PGBR, p. 441, Pl. I, fig. E, type, Busk Coll. 99. 7. 1. 70, Australia; text-fig. 17, A and C—G operc., mand., from the same specimen; B from 99. 7. 1. 2954, same locality; text-fig. 16. Great Barrier Reef. 32. 4. 20. 73.

Group A. 443. A. Stat. 47. Bima, Sumbawa, N., 55 M. Fragments, old.
247. A. Stat. 310. Sumbawa, E., 73 M. Several.
346. C. Stat. 213. Saleyer, S. of Celebes, 0—36 M. 2 col.
Group C. 297. A. Stat. 273. Jedan, Aru Is., 13 M. Fragment.
300. A. Stat. 273. Jedan, Aru Is., 13 M. Several.
670. A. Stat. 373. Jedan, Aru Is., 13 M. 1 col.

193. A. Stat. 274. Off Jedan, Aru Is., 57 M. Many.
195. A. Stat. 274. Off Jedan, Aru Is., 57 M. Several.
197. A. Stat. 274. Off Jedan, Aru Is., 57 M. 1 old col.

British Museum: —

Type. Australia, BUSK Coll. 99. 7. 1. 70. (*Retepora benemunita* Busk, MS.), selected by Miss HASTINGS as the type of *R. monilifera*, var. *benemunita*; and other specimens of BUSK's from the same locality.

Specimens from the 'Challenger' Collection, Torres Straits, 8 fath., referred by BUSK to *Retepora tubulata*, as follows; —

87. 12. 9. 502; the smaller of two colonies.
87. 12. 9. 501; 99. 7. 1. 3173, 3176, 3180.

Cambridge, Mus. Zool.: —

Torres Straits, A. C. HADDON Coll., 16, 19. A, 25. Reg. Feb. 24, 1898.

Busk failed to notice that the material described by him as *Retepora tubulata* consisted of two species, the more striking differences between which I have indicated above (p. 602). A MS. name which had been given by him to certain specimens from "Australia", in the British Museum, has been used by Miss HASTINGS (1932) in describing these, with other material recently obtained on the Great Barrier Reef. The specimens dredged by the Siboga and those from Torres Straits agree in every important respect with her account. Miss HASTINGS regarded this form as a variety of *Retepora monilifera* MacGill.; but I think it deserves specific rank, and I have accepted BUSK's MS. name used by her as that of a variety.

The distribution, as shown by the above localities, is entirely from shallow water off the Aru Is, Flores Sea and Sumbawa, in addition to the type-locality, Torres Straits and the Great Barrier Reef.

Zoarium (Pl. XXXV, figs 25, 26) tubular, the tubes and funnels smaller, more delicate and compact than in *T. inornatum* (p. 608), the orifices on the inner surfaces. Fenestrae small, more or less oval, commonly deformed by projecting ovicells; the trabeculae usually stout, 2—4 serial. Labial pore small, near the margin of the peristome. Labial avicularium horizontal or oblique, sometimes making a slight cusp. Spines 1 : 1, very short and thin, generally wanting. Infrafenestral avicularia short, with 2 or 3 cusps, facing the fenestra, the mandible bifid or bilobed, not conspicuously widened at the origin of the two lobes, less than twice the width of the base at this level. Large frontal avicularia often numerous, horizontal, or more or less raised distally, unicuspid or slightly bicuspid, the mandible not toothed. Munitiform avicularia occasionally found. Ovicells delicate, not mucronate. Large basal avicularia either long, slightly widening distally, the mandible acuminate; or shorter, widening distally, the mandible bifid like those of the infrafenestral avicularia.

The young peristomes are moderately raised proximally, their orifices facing obliquely distally; but, as in other species, they become immersed later and face frontally. The labial pore (Pl. XXXIX, fig. 25) is generally small and near the edge of the peristome, rarely remaining unclosed as a small sinus. The labial avicularium (fig. 20), which often fails to develop, may form a small cusp on the peristome, but is often horizontal and not projecting.

As in other species, there is much variation in the number of avicularia. The characteristic

infrafenestral form (fig. 20) has been found in all the specimens, sometimes in a considerable proportion of the fenestrae, in other instances in only one or two fenestrae. Owing to the vertical position of the palatal surface and to the fact that the avicularia often project but little into the fenestrae, the number of cusps has not been ascertained in all cases, but it is generally 2, one frontally situated and the other more basally. In some instances the rostrum is tricuspid, one cusp being submedian, smaller than the other two and apparently belonging to the frontal half of the rostrum; in contrast with *T. tubulatum*, in which there are commonly two basal cusps. In correlation with the narrower termination of the mandible (Pl. XXXIX, fig. 26, *l*), the rostrum is generally less widened distally in this species than in *T. tubulatum*. Munitiform avicularia (fig. 25, *M. av.*) are less common and are usually suprafenestral. They have been found by Miss HASTINGS (1932, text-fig. 16, *av*); and they occur in the Siboga specimens 193. A, 195. A, 300. A, as well as in Torres Straits 19. A. Bicuspid frontal avicularia are present in all the Siboga specimens except 195. A and 197. A, and they may be very numerous or very rare, with intermediate frequencies. They are often small, but occasionally very large, as shown by Miss HASTINGS, text-fig. 17. B (mandible). 300. A is remarkable for having 10 kinds of avicularia, the mandibles of which are described below; — other specimens being less plentifully supplied. Small frontal avicularia are generally present; mostly round, sometimes less abundant in parts where bicuspid avicularia are numerous but being specially abundant, as in other Retepores, on or among the ovicells.

The ovicells (fig. 20) are very delicate, non-mucronate, the median arm of the stigma sometimes much reduced, the lateral arms short, straight or slightly curved, diverging at 180° or less. The ovicells are generally present in large numbers, many projecting into the fenestrae.

The basal surface may be strongly tubercular in the young state, but is generally less tubercular or merely granular in older trabeculae. The specimen described on p. 530 (text-fig. 28) illustrates the Hydroid orifices (*H. O*). The vibices are thin and projecting in young parts, but in the older condition they are generally weak and inconspicuous. Avicularia with bifid mandibles may occur basally (Pl. XXXIX, fig. 22), where a large immersed avicularium only slightly widened distally (fig. 23) may also be found, its unbranched mandible of the kind shown by Miss HASTINGS (text-fig. 17. A). Small avicularia may be very numerous on this surface (text-fig. 28).

The opercula (Pl. XXXIX, fig. 26, *a*) are evenly rounded distally, with a narrow marginal sclerite. The mandibles are of many kinds, distributed in various combinations among the specimens, but in 300. A alone with what may be regarded as the full complement. The profusion of avicularia in this specimen amply justifies BUSK's MS. name *benemunita*; and by comparison with it most of the others with a less complete representation of avicularia can be recognized as belonging to the same species. No less than 10 forms of mandible can be distinguished in 300. A (fig. 26), as follows; (1) *k*, *l*, infrafenestral bifid, the two distal lobes shorter than in *T. tubulatum* and arising from a less widened part of the mandible; this type constituting one of the most distinctive features of the species and occurring in most of the specimens. The strong occlusor muscle is inserted very near the base (*k*), indicating that the mandible probably closes rapidly; (2) *m*, a much larger basal form of the same type, less common, often longitudinal and infrafenestral, the rostrum directed proximally, so that the mandible, opened to its full extent of 180°, projects distally into the fenestra and may be visible in frontal view;

(3) *e*, a very large and broad basal type, its apex deflexed and acute; (4) *d*, a lateral fenestral of the same kind, ascending almost vertically from the basal surface, so that its large distal triangular cusp, at right angles to the rest of the mandible, is found at the level of the frontal surface; *c* being another mandible of the same type, seen from the distal end, the shaded part to the left being the foreshortened remainder of the mandible; (5) *f*, munitiform, strongly chitinized, occurring suprafenestrally and elsewhere, frontally, and also basally, the occlusor muscle being very powerful; (6) *g*, small round, wider than long, with strong occlusor muscles, common on the frontal surface; (7) *n*, small oval, most frequent basally, the mandible very delicate, the muscles much weaker; (8) *b*, acute frontal, common in many of the specimens; (9) *i*, *j*, long, curved, marginal, acute, sometimes more elongate than those figured; (10) *h*, labial, longer than in many of the other species.

Miss HASTINGS (1932, text-fig. 17) has figured types 1, 3, 6 and 10 of these mandibles. She described the labial mandible as ending in an acute point, an observation I have been unable to verify, although I do not dispute its accuracy.

6. *Triphyllozoon inornatum*[1]) nom. nov. (Pl. XXXV, fig. 29; Pl. XL, figs 1—4; text-fig. 38, p. 610).

Retepora simplex Busk, 1884, Chall., p. 118, Pl. XXVIII, figs 4, 4*a*; text-fig. 28 (operc., mand.). Admiralty Is. (New Guinea); Samboangan (Philippine Is.), 10 fath.
(nec *Retepora simplex* Busk, 1859, FPC, p. 76, Pl. XII, fig. 3, *a—f*).
? *Retepora simplex* Thornely, 1905, PGM, p. 125 (no description). Ceylon.

Group A. 24. A. Stat. 53. Nangamessi Bay, N. Sumba, 0—36 M. Probably 1 col. and another, young.
231. A. Stat. 305. Solor Strait, E. Flores, 113 M. Several.
410. B. Stat. 305. Solor Strait, E. Flores 113 M. Fragments.
219. A. Stat. 302. Between W. Timor and Rotti Id., 216 M. 1 col.
Group B. 469. A. Stat. 95. Sulu Archipelago, 522 M. 1 col., dead (469. B, *Iodictyum projectum*, on the same slide).
Group C. 297. F. Stat. 273. Jedan, Aru Is., 13 M. Fragments.
201. A. Stat. 282. Timor, E., 0—54 M. 1 col.
216. A. Stat. 285. Timor, E., S. coast, 34 M. 1 col.

British Museum: —

Type Admiralty Is., Challenger Coll. (BUSK), 87. 12. 9. 490.
Philippine Is., Challenger Coll. (BUSK), 87. 12. 9. 491.

Miss THORNELY's record from Ceylon must be considered doubtful until evidence is obtained that her specimen was correctly determined.

Zoarium (Pl. XXXV, fig. 29) at least 85 mm. in diameter, infundibuliform, the orifices on the inner surfaces, resembling those of *T. philippinense* (in which the orifices are external) but with larger tubes and funnels. Fenestrae rather large, subcircular or oval, frequently deformed by projecting ovicells; in younger parts wider than the trabeculae, which are usually 2—3 serial. Peristomes with an even, circular orifice, not much projecting, the labial avicularium generally horizontal, occasionally forming a slight cusp. Labial pore small, near the margin of the peristome.

1) This name is chosen as conveying much the same idea as BUSK's name *simplex*.

Spines not found, nor even their bases. A massive avicularium (Pl. XL, figs 1, 2, *S. av*) at the proximal end of the fenestra, but of rare occurrence, extending up one side of the fenestra (rarely one on each side); the rostrum long, ascending obliquely proximally, facing frontally and distally, the mandible subacute, the associated peristome sinuate (fig. 2). In other fenestrae a more ordinary infrafenestral avicularium (text-fig. 38, C), widening distally, bicuspid or tricuspid, the mandible bifid. Small bicuspid frontal avicularia with rounded mandibles, not common. Munitiform avicularia found rarely. Ovicells delicate, about as long as wide, with no trace of mucro; the median arm of the stigma generally short, sometimes almost wanting. Large immersed basal avicularia, the rostrum long, widening distally.

The large fenestral avicularia (Pl. XL, figs 1, 2, *S. av*) appear to constitute the most distinctive feature of *T. inornatum*. They occur in Busk's slide 87. 12. 9. 490, from the Admiralty Is (N. of New Guinea), and for this reason I select it as the type-specimen. It shows a moderate number of these avicularia, which are presumably the "scattered prehensile avicularia (readily overlooked)" of Busk's description; — the strong, wide, subacute and asymmetrical mandibles I show in fig. 3, *a* and in fig. 4, *c* being closely similar to the middle of three long mandibles figured by him in his text-fig. 28. These avicularia, which are unlike any I have found in other species, are large and long, sometimes constituting nearly half of one margin of a fenestra (fig. 1), the rostrum ascending from the basal side and directed obliquely proximally. As shown by a decalcified preparation (fig. 3, *a*), the occlusor muscle is extremely powerful.

297. F (Pl. XL, figs 1, 2) has these avicularia fairly commonly, several fenestrae having one on each side; and 24. A also shows them well. Although I have found them in all the specimens except 231. A, in three of them only one such avicularium could be discovered by careful examination of a large number of fenestrae. It is unfortunate that this characteristic feature is so commonly wanting, even in considerable regions of colonies which have been proved to possess at least one. In the absence of these avicularia, *T. inornatum* may be very difficult to distinguish from *T. benemunitum*; and the other characters on which I have principally relied are the stouter growth of the tubes and funnels of the zoarium, in the former; and the rounded mandibles (fig. 3, *c*) of its frontal avicularia, in contrast with the acute mandibles of the corresponding avicularia of the latter. These frontal avicularia also are most capricious in their occurrence, and I have found them only in 24. A, 231. A and 410. B.

The frontal surface is nearly always granular or smooth, pellucid in the young condition and without tubercles. The trabeculae (fig. 1) have a simple character, which Busk probably alluded to in his choice of a name, with very regularly arranged peristomes, more or less raised proximally in the young condition, with nearly circular orifices and sometimes a slight projection of the labial avicularia. The rostra of these avicularia are rather longer than in most of the other species. Small frontal avicularia are often excessively rare; but they may be more frequent and are apparently of the round type. The presence of the Gymnoblastic Hydroid frequently associated with specimens of *Triphyllozoon* is indicated in Pl. XL, fig. 2, where *H* is an open calcareous groove, with an orifice below it and a closed tube more proximally. Large bicuspid or tricuspid infrafenestral avicularia, resembling those of *T. benemunitum*, have been found in all except 24. A, 201. A and 469. A; and when it has been possible to observe the mandibles (fig. 4, *b*) they have been found to be bifid, as in that species. Munitiform

avicularia occur in two specimens. In 297. F (figs 1, 2, *M. av*) they are frequent and rather large, suprafenestral and with a large obliquely longitudinal orifice.

The ovicells (Pl. XL, fig. 2), which are not mucronate, are often present in great profusion, many of them projecting into the fenestrae. The appearance of ovicell-bearing trabeculae is very different from that of non-fertile trabeculae; and two fragments, respectively with and without ovicells, do not appear at first sight to belong to the same species. In the absence of all avicularia, as is commonly the case, a fragment without ovicells has few features by which the species can be recognized.

The basal surface (text-fig. 38, A) resembles the frontal surface in texture, but it may be slightly or definitely tubercular. Busk stated that there were no distinct vibices, but they occur in all the Siboga specimens, and in certain states of growth they are strong. One or two munitiform avicularia occur basally in 297. F and in 219. A. The very large, immersed basal avicularia (text-fig. 38, B) are fairly common, and they occur in all except 201. A, 216. A and 469. A. In one or two instances a shorter bicuspid avicularium was found basally. Small oval avicularia are fairly common here (text-fig. 38, A), both on the general surface and in the margins of the trabeculae.

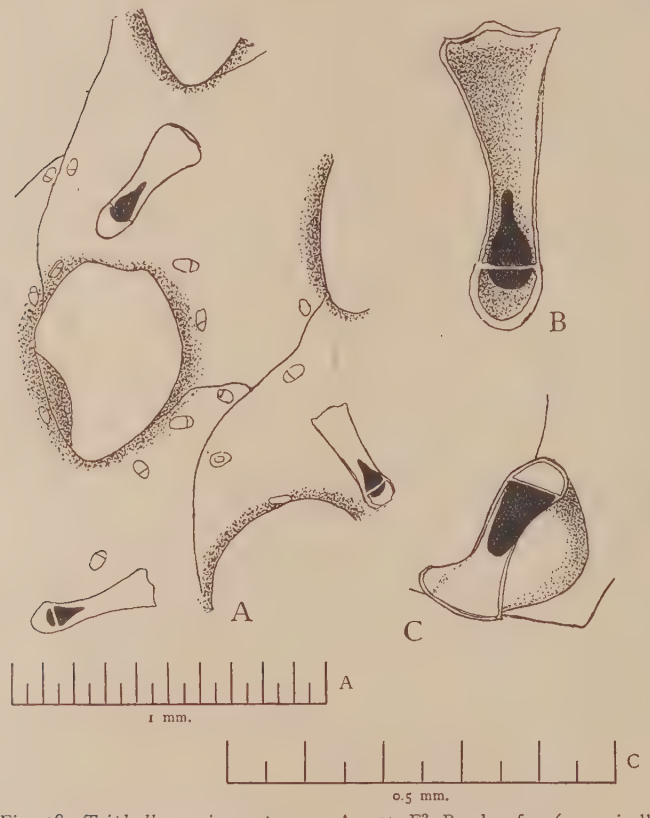

Fig. 38. *Triphyllozoon inornatum.* — A, 297. F². Basal surface (one ovicell partly visible). Obj. A. — B, same piece. Immersed basal avicularium. Obj. C. — C, same piece. Infrafenestral avicularium of bicuspid type, frontal view. Obj. C.

The opercula (Pl. XL, figs 3, *a*, *b*) are hardly distinguishable from those of *T. benemunitum*. The characteristic fenestral mandibles (figs 3,*a* and 4,*c*) are asymmetrical and, as shown in fig. 3, their occlusor muscle is very powerful. The bifid infrafenestral mandibles (fig. 4, *b*) resemble those of *T. benemunitum*, and the occlusor tendon is inserted close to the base, as in that species. The long frontal mandibles (fig. 3, *c*) are rounded distally, in contrast with those of the other species (Pl. XXXIX, fig. 26, *b*). The larger basal mandibles (Pl. XL, figs. 3, 4, *d*) are simple or slightly bifid distally; and, as in other species, are considerably larger than those of the frontal surface. The labial mandibles (fig. 3, *e*, *f*), which vary in size, are relatively large and are frequently longer than wide.

It is uncertain whether Busk, when describing a 'Challenger' species as *Retepora simplex* n. sp., had forgotten his earlier introduction of the same name for a species from the English Coralline Crag, or whether he was following the practice adopted by some authors of placing "n. sp." after the names of their own species whenever they refer to them. But in any case it cannot be assumed that *R. simplex* 1859 and 1884 are identical, particularly in view of the

fact that the characters of the mature ovicells of the fossil are unknown. Its two spine-bases, as figured by Busk in 1859, should however be noted, since these structures seem to be wanting in the recent species.

Waters (1888, Chall., p. 22) had previously remarked on Busk's double use of the name; but his suggestion that *R. simplex* (1884) should be known as *Retepora magellensis*, var. *minima* was unfortunate. *R. magellensis* had been described by Busk (1884, p. 126) from 600 fathoms, off Buenos Aires. He described 4—6 spines, but he did not find ovicells. These were later described, in *R. magellensis*, var. *aviculifera*, a new variety from the same neighbourhood, introduced by Calvet (1904, DBN, p. 58; 1904, HMS, p. 33, Pl. II, fig. 5), and were shown to have a linear median slit, not a trifoliate stigma. Even if Calvet's variety has no bearing on the question (as having no connexion with *R. magellensis* Busk), it is improbable that the Malay, mainly shallow water species is a variety of an abyssal species from off S. America.

7. *Triphyllozoon trifoliatum* [1]) n. sp. (Pl. XXXV, fig. 32; Pl. XL, figs 5—9; text-fig. 39).

Group A.	Type.	281. D.	Stat. 43.	Pulu Sarassa, Postillon Is., 0—36 M. Several.
		282. B.	Stat. 43.	Pulu Sarassa, Postillon Is., 0—36 M. 1 small col.
		430. A.	Stat. 43.	Pulu Sarassa, Postillon Is., 0—36 M. Fragments.
		20. F.	Stat. 50.	Badjo Bay, W. Flores, 0—40 M. 1 minute col.
		317. B.	Stat. 50.	Badjo Bay, W. Flores, 0—40 M. 1 young col.
		328. A.	Stat. 64.	Tanah Djampeah, between Flores and Celebes, 0—32 M. Several.
		333. A.	Stat. 64.	Tanah Djampeah, between Flores and Celebes, 0—32 M. Fragment.
Group C.		121. A.	Stat. 164.	W. of N. end of New Guinea, 32 M. Fragment.
	? sp.	512. A.	Stat. 169.	Atjatuning, W. coast of N. end of New Guinea, 0—57 M. Fragments.
		278. A.	Stat. 250.	Kur Id., Kei Is., 0—45 M. Several.
		279. A.	Stat. 250.	Kur Id., Kei Is., 0—45 M. 3 col.

As represented by these specimens *T. trifoliatum* shows a restricted distribution in the Archipelago; occurring only in the Java and Flores Seas and off the W. end of New Guinea.

Zoarium (Pl. XXXV, fig. 32) saucer-shaped, laminate and wavy, or producing tubes with external orifices. Peristome denticulate proximally, cusped by the labial avicularium, which has a long, narrow, acute rostrum and mandible. Labial pore moderately distant from the edge of the peristome. Spines (20. F) 3 : 3, long, more or less jointed and even antenniform, but more usually represented by bases, 1 : 1, in the older state. Median infrafenestral avicularia large, usually descending vertically, the rostrum contracted at the middle, wide at the distal end, which has 2 specially prominent cusps; the mandible long, strongly trifoliate. Ovicells flat in front, with a recurved acute mucro, often obliterated by inclusion in a large, spike-like vertical avicularium, to the apex of which the acute, narrowly triangular rostrum ascends; the lateral arms of the stigma long and much curved inwards. Munitiform avicularia and (with one exception) other large frontal avicularia not found. Small avicularia rare and often hardly to be found frontally. A few small oval avicularia in the margins of the fenestrae basally, where large avicularia are almost invariable wanting.

1) In allusion to the mandibles of the infrafenestral avicularia.

The zoarium may be at least 30 mm. wide. The mode of formation of tubular portions is well illustrated by specimens from Stat. 250. These were growing on a coral with narrow branches, and at an early stage their laminae had grown backwards round their nearly linear support. The union of two lobes by their basal surfaces, in one or two instances, naturally produced tubes or funnels with external orifices. Another colony had preserved its saucer-like shape as far as possible, but had grown between the branches of the coral, to which it had formed secondary attachments. The fenestrae are of moderate size, oval, often pointed at both ends, generally wider than the rather delicate trabeculae, which are commonly 2—3 serial.

The young zooecia are elongate, outlined by thin septal lines, which may project enough to form very shallow marginal valleys. The septal lines often persist in the older state, in which distinct marginal pores may occur; frequently a proximal pair and one or two lateral on each side. The flattened or slightly convex surface of the young zooecia (text-fig. 39, B) rises

Fig. 39. *Triphyllozoon trifoliatum.* — A. 281, D^3. Basal surface, showing cusps of infrafenestral avicularia. Obj. A. — B, Same slide. Young peristomes. Obj. C.

to the apex of the swollen labial avicularium, which is prominent and more or less conical, flattened on the side facing the orifice. It lies on the margin of the peristome, which is denticulate proximally, often continuing to project as a small cusp when the peristome has become immersed. The cusp in the younger state may be flattened or slightly grooved on its distal side, and then has the appearance of a projecting tongue. The avicularium, on one side of the cusp, is vertical or faces obliquely frontally, and its inflated base is responsible for the frequently asymmetrical position of the labial pore, on one side of the middle line. The acute character of the labial avicularium (see also Pl. XL, fig. 5) in this species is an unusual feature.

The very young colony 20. F is not determined with complete certainty, but it resembles 317. B (from the same Station), which shows the characteristic features of the species. Each group of 3 spines, in 20. F, is formed by trifurcation of a single base at the distal, lateral edge of the peristome (Pl. XL, fig 8). In 430. A, a young colony with good evidence for its determination, 2 : 3 spines were found (3 on the outer side); and an inner spine on another zooecium was strong and antenniform, with a long proximal segment and 3 short terminal segments.

The infrafenestral avicularia (Pl. XL, figs 6, 7), which are longitudinal and median, were found in representatives of all Stations except 169 and 250. They are liable to be overlooked in consequence of their steep descent into the fenestrae. Except in position they closely resemble the fenestral avicularia of *T. indivisum* (see p. 615). They are most numerous in 281. D, particularly in a young colony (281. D^3), 16 mm. in diameter. The derivatives of the ancestrula can be recognized at the centre, which is partially obscured. Avicularia of this type occur on at least 3 of them, as unilateral frontal structures commencing at the middle of the zooecium and directed obliquely distally. One is opposite an early fenestra and constitutes its infrafenestral avicularium. A large proportion of the fenestrae are thus provided, and two of them have each two such avicularia, produced frontally by the proximal marginal zooecia on either side of the fenestra. As these two zooecia are not opposite one another, one of the avicularia is correspondingly the more distal in the fenestra. Other specimens do not suggest that these avicularia are specially characteristic of young colonies; and in 328. A no such avicularia could be found in a young colony, and one only (with much difficulty) in part of an older colony.

With the exception of 512. A, in which there are two swollen, broken or imperfect structures apparently representing avicularia of the large bicuspid type, no large avicularia, other than those associated with the ovicells (see below) have been found on the frontal surface. 333. A has a moderate number of small oval frontal avicularia, of which an occasional representative occurs in the margin of a fenestra in other specimens, in some of which they are rarer or have not been found. Small round avicularia seem to be nearly always wanting even among the ovicells, a position in which they are common in other species. I have some evidence that the spike-like avicularia of the ovicells (Pl. XL, fig. 5) may be the modified labial avicularia of adjacent zooecia, although the spike on an ovicell is not produced by an avicularium belonging to its own zooecium. A labial avicularium not associated with an ovicell may be considerably enlarged; and in a few instances two are present, one on either side of the labial pore.

The ovicells (fig. 5) may become confluent by secondary calcification, and the connecting parts are formed by the bases of the avicularia described in the preceding paragraph. The characters of the ovicells with their associated avicularia suggest that this species might be identical with *Retepora monilifera*, var. *umbonata* MacGill., a name for which I have proposed to substitute the designation *Triphyllozoon cuspidatum* (1933, GR, p. 623). From MacGillivray's description (1885, PZV, Dec. X, p. 23) and from my examination of Victorian specimens of this species in the Cambridge Collection, I believe that the resemblance is superficial and that the two species differ widely in most other respects. In *T. cuspidatum* the mucro of the ovicell is long and acute, but it belongs to the ovicell, as shown by the fact that the median arm of the stigma ascends, or may ascend, along it to its apex, and it is accordingly much longer than the lateral arms, which are only moderately curved. Munitiform avicularia occur suprafenestrally in *T. cuspidatum* and there are numerous small, narrow, bicuspid avicularia, projecting into the fenestrae or occurring on the frontal surface of zooecia not related to the fenestrae. Avicularia of the small kinds, round and oval, are specially common frontally, particularly on or among the ovicells; a small oval avicularium often occurring on the base of the mucro, but not reinforcing it to form a spike. There are no specialized infrafenestral avicularia. In practically all these characters *T. trifoliatum* differs from *T. cuspidatum*.

Retepora umbonata Buchner (1924, UJR, p. 206), a possible synonym of *T. bimunitum* (see p. 618), from Japan, appears to be distinct from *T. cuspidatum* and *T. trifoliatum*, as shown by the enormous decurved mandibles of its large, transversely placed infrafenestral avicularia figured by this author on p. 207, text-fig. U, *b*, *c* (cf. HARMER, 1933, GR, p. 624). The evidence of the ovicells figured by him (text-fig. D, p. 167) shows that it should be referred to as *Triphyllozoon umbonatum*.

The basal surface of *T. trifoliatum* (text-fig. 39, A) is more or less tubercular or granular; the vibices, generally longitudinal, rather more numerous than in most of the other species. A single large, immersed infrafenestral avicularium, without cusps but otherwise like the ordinary infrafenestral avicularia, was found in 121. A. With this exception, large basal avicularia are wanting. The terminal cusps of the steeply descending frontal infrafenestral avicularia reach the basal surface and are sometimes easily seen in basal view.

The opercula (Pl. XL, fig. 9, *b*, *c*) have a weak marginal sclerite and are evenly rounded. The infrafenestral trifoliate mandibles (*g*, *h*) are a characteristic feature of the species, as is the acute form of the labial mandibles (*d*, *f*); *a* is one of the acute mandibles associated with an ovicell; *e* is an ordinary frontal acute mandible; and *i* is a frontal oval. The decalcified ovicells differ from those of *T. hirsutum* in being so slightly chitinized that the details of the stigma are not observable.

8. *Triphyllozoon indivisum*[1]) n. sp. (Pl. XXXV, figs 33, 34; Pl. XL, figs 10—12; text-fig. 25, F, p. 519; text-fig. 40).

Group A. Type 346. A. Stat. 213. Saleyer, S. of Celebes, 0—36 M. Several.

Zoarium (Pl. XXXV, figs 33, 34) shortly stalked, saucer-shaped. Fenestrae elongate, about 1 × 0·5 mm., generally rather wider than the 2—4 serial trabeculae. Labial pore closed, near the edge of the peristome; labial avicularium apparently wanting. Lateral fenestral avicularia extremely large and conspicuous, in the proximal half of the fenestrae on one or both sides, occupying most of the frontal surfaces of their zooecia. Rostrum narrowest near the middle of its opesia, then widening and becoming very strongly bicuspid; directed obliquely proximally and facing frontally; the mandible markedly trifoliate. Small round frontal avicularia usually median; oval avicularia in the margins of the fenestrae, on both surfaces. Ovicell slightly mucronate, its stigma median, with no vestige of lateral arms. Large avicularia of the frontal marginal type may occur basally.

This very interesting species was represented by 3 or 4 colonies from a single Station. The fenestral avicularia are hardly distinguishable in form from those of *T. trifoliatum* and *T. bimunitum*. Their trifoliate mandibles agree closely with those of the former species, while in *T. bimunitum* the mandibles, although simple, are widened in such a way as to suggest an approximation to the trifoliate mandibles of *T. indivisum*. These resemblances to undoubted species of *Triphyllozoon* are a sufficient justification for including *T. indivisum* in that genus, in spite of its aberrant ovicell.

The largest colony (Pl. XXXV, figs 33, 34) was a flat cup with a radius of 21 mm.

1) Undivided, in allusion to the stigma of the ovicell.

in its most complete part. The fenestrae are deformed by the projection of the marginal avicularia. Young zooecia (text-fig. 40) are short, slightly convex, irregularly tubercular, the septal ridges moderate, the marginal pores sometimes 2 on either side, one at the proximal corner, the other not far from the secondary orifice. The peristome, not denticulate proximally, is raised proximally and laterally, and its orifice is at first subquadrangular, slightly longer than wide. The relation of the asymmetrical sinus of the primary orifice to the labial tube and labial pore is specially well shown in this species (text-fig. 25, F, p. 519; text-fig. 40; Pl. XL, fig. 12), and has been described above (p. 520). When immersed, the edge of the peristome is even and nearly circular. Spines are at most represented by obscure spine-bases in young zooecia.

Fig. 40. *Triphyllozoon indivisum.* — 346. A³. Part of the growing margin. The median peristome shows the primary orifice, with a proximal lyrula and an asymmetrical sinus. The right one shows also a young ovicell; the peristome, hardly raised at present, has prolonged the primary sinus into a short sinus-groove, ending in the sinus of the secondary orifice. This is more developed in the left peristome, where the primary orifice is no longer visible. Obj. C. (Cf. Pl. XL, fig. 12).

The palatal surface of the large marginal frontal avicularia (Pl. XL, fig. 11) is formed by two planes, intersecting almost at right angles at the calcareous bar; that of the rostrum descending more or less into the fenestra, and that of the proximal opesia to the frontal surface of the zooecium. The three leaves of the closed mandible extend considerably beyond the rostrum, the median leaf lying between the two cusps and the lateral branches on their proximal sides. An occasional avicularium of this type, but usually smaller, may occur on a median zooecium or even on an ovicell. A small round frontal avicularium with denticulate rostrum (rarely paired) is sometimes found proximally, near the preceding peristome. Those which occur unilaterally on an ovicell are the displaced avicularia of the succeeding zooecium. Small oval avicularia are rare frontally.

The ovicells (Pl. XL, fig. 11) are longer than wide, at first delicate and prominent distally, where a slight mucro terminates a linear stigma with two longitudinal series of pores; the lateral branches of the stigma being not even vestigial. The descending lamina terminates in a wide labellum with a convex free edge.

The basal surface is subgranular, with a few larger tubercles; the vibices few and inconspicuous in the young state, when the outlines of the zooecia may be distinguishable through the thin primary kenozooecia, in basal view; — an unusual feature. Large immersed basal avicularia are common in some parts, directed away from a fenestra, the rostrum wide and rounded terminally, without cusps, the mandible trifoliate like those of the large frontal avicularia, or with the lateral leaves suppressed or barely indicated by a slight widening. Small oval avicularia are deeply placed in the basal margins of the fenestrae.

The opercula (Pl. XL, fig. 10, *b*, *c*) have a specially strong marginal sclerite distally and laterally, the lateral edges being often straight, with an approach to an angle as they begin to become distal. In these characters they differ from most other species of the genus, among which little help in determination is usually given by the opercula. The fenestral mandibles (*a*, *d*) are equally characteristic, by their large size and pronounced trifoliate form; *e* is a small round

frontal mandible. The oval avicularia, which are relatively large, are seen edgeways in my preparations, and I have not found a mandible suitable for figuring.

9. *Triphyllozoon bimunitum* (Ortm.) (Pl. XXXV, fig. 39; Pl. XLI, figs 1—8, 11—13; text-fig. 25, C, p. 519; text-fig. 41, p. 617).

Retepora bimunita Ortmann, 1889, JB, p. 34, Pl. II, fig. 22. Japan, 200 fath.
Retepora bimunita Buchner, 1924, UJR, p. 205. Japan.
Retepora bimunita, var. *trimunita* Buchner, ibid., p. 204, Pl. XVII, figs 1, 2. Japan, 180 M.
? *Retepora bimunita*, var. *sparsimunita* Buchner, ibid., p. 206, Pl. XVII, figs 3, 4; text-fig. T, p. 206 (operc., mand.). Japan.
? *Retepora antennula* Buchner, ibid., p. 200, Pl. XV, figs 11, 12. Japan, 250 M.
? *Retepora umbonata* Buchner, ibid., p. 206, Pl. XVII, figs 6, 7; text-fig. D, p. 167; text-fig. U, p. 207 (operc., mand.). Japan.
? *Triphyllozoon magniscutulatum* Canu and Bassler, 1929, BPR, p. 373, Pl. XLIX, figs 7—12; text-fig. 141, p. 366, C—E (operc., mand.). Philippine Is., 58 fath.

Group A. 32. A. Stat. 65.*a*. Tanah Djampeah, between Flores and Celebes, 120—140 M.
Group C. 108. B. Stat. 144. S. of Halmaheira (Djilolo), 0—45 M.
111. G. Stat. 156. W. of Waigeu Id., 469 M.
112. F. Stat. 156. W. of Waigeu Id., 469 M.
113. A. Stat. 159. W. of Salawatti, N. end of New Guinea, 411 M.
144. A. Stat. 166. W. of N. end of New Guinea, 118 M.
184. A. Stat. 260. Kei Is., 90 M.

Cambridge, Mus. Zool.: —

BM Japan, 40 fath. A. Owston Coll. 5 W. Reg. June 23, 1902.

The specimens were in all cases incomplete fragments. With the exception of the first and of the Japanese specimen, they are all from the neighbourhood of the W.end of New Guinea.

Zoarium (Pl. XXXV, fig. 39) expanding nearly in one plane. Fenestrae often large, up to 3 × 2 mm., elongate, rhomboidal; trabeculae narrow, mostly 2—3 serial. Labial pore (text-fig. 25, C, p. 519) closed, connected with the edge of the peristome by a labial suture of varying length, sometimes long; opening into a long labial tube (text-fig. 41, B, *l. t*). Large lateral avicularia produced at the proximal ends of marginal zooecia, conspicuous, inflated, often more than one in a fenestra and usually confined to its proximal half; rostrum in contact with the outer margin of the preceding peristome, narrower at the middle, widening to a strongly bicuspid termination, the acicular decurved end of the mandible extending beyond the cusps; typically directed obliquely proximally (less often distally) and usually descending, facing frontally or towards the fenestra. Other large avicularia hardly represented frontally, but common basally. Small avicularia often excessively numerous in the older parts, both frontally and basally. Primary ovicells longer than wide, becoming much thickened later by secondary calcification. Median arm of stigma generally the longest, the lateral arms straight or slightly curved, diverging at almost 180°, or at a more acute angle.

A trabecula is occasionally barren or uniserial. The young zooecia are elongate, convex, the septal lines not prominent, the marginal pores inconstant, sometimes 2—3 on one or both sides; or wanting. The young peristomes (text-fig. 41, B) are raised, especially proximally and laterally. One half of the proximal margin is generally straight or slightly curved, the other

half modified by a swollen labial avicularium with a round rostrum hardly projecting. The labial pore is connected with the edge of the peristome by a labial suture of varying length, and it opens into a long labial tube (*l. t*). A straight, horizontal, finely denticulate ridge (as in text-fig. 39, B, p. 612, *T. trifoliatum*) occurs on the inner proximal margin of the peristome. The spines are 1 : 1 (median) or 1—2 : 2—3 (marginal zooecia), usually represented at most by their bases. The inner spine of many young zooecia (Pl. XLI, fig. 5) is long, occasionally stouter than the others and jointed or even antenniform; the others shorter, slender and not or obscurely jointed.

The frontal and basal avicularia vary much in number and are of the following kinds; —

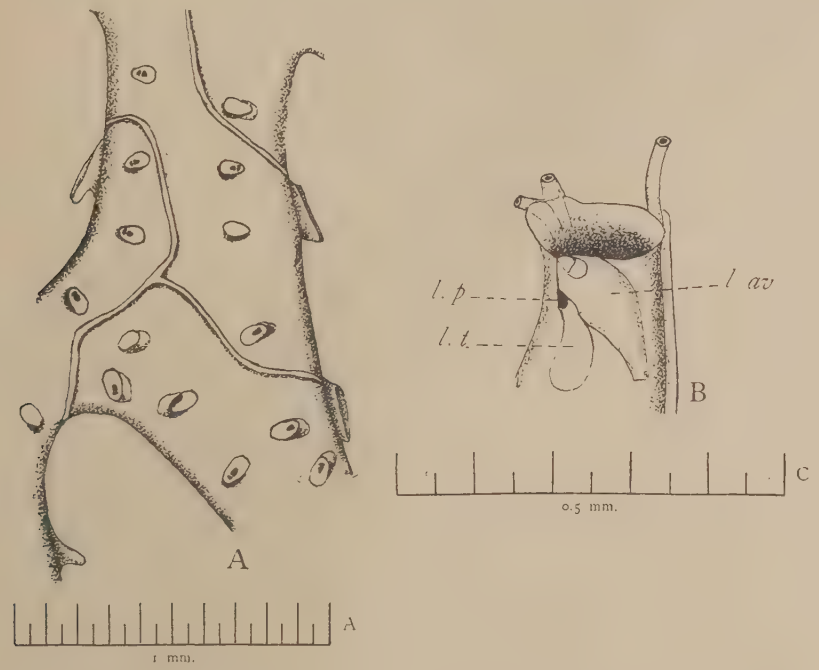

Fig. 41. *Triphyllozoon bimunitum*. — A, III. G¹. Basal surface. Obj. A. — B, same slide. Young peristome with semitransparent wall, through which can be seen; — *l. t*, the labial tube, opening at the labial pore, *l. p*, and traceable to the base of the peristome, where it is close to the proximal margin of the operculum; *l. av*, tubular cavity of the labial avicularium, inflating one wall of the peristome. Obj. C.

(1) Pl. XLI, figs 1, 8; extremely large, fenestral (see diagnosis), found in all the specimens; (2) small, round, like the labial avicularia, sometimes forming blister-like swellings (fig. 2), their mandibles sometimes almost semicircular but usually wider than long; (3) rather larger, oval, horizontal, slightly raised or immersed (figs 2, 8).

The ovicells (Pl. XLI, figs 1, 8) are at first delicate, becoming much thickened later, especially at the sides of the stigma, by secondary calcification; the front surface being then flat and ending in a more or less definite mucro, which may be acute and long. A young ovicell (Pl. XLI, fig. 6) is described on p. 524.

The synonymy of this species is doubtful, and the specimens I describe may not all belong to the same species. ORTMANN's short description implies that his *Retepora bimunita* had numerous large frontal and fenestral bicuspid avicularia; and the frequency of such avicularia in the Siboga specimens seems a good reason for referring some at least of them to his species; —

a conclusion confirmed by my examination of a specimen from the type-locality (Japan). BUCHNER described two new varieties; and of these var. *trimunita* seems to be correctly placed under *R. bimunita*; but I am not satisfied that the other, var. *sparsimunita*, belongs to that species. *Retepora antennula* Buchner, in which ovicells were represented merely by immature stages, may well have been a young condition of some other species. Its long labial suture (which BUCHNER described as a sinus) and the antenniform spines suggest that it may be a young stage of *Triphyllozoon bimunitum*. *Retepora umbonata* is another species introduced by BUCHNER, with the assumption, as shown by his synonymy, that it is identical with *Retepora monilifera*, var. *umbonata* MacGill. As indicated above (p. 613) I subsequently (1933) proposed the name *Triphyllozoon cuspidatum* for MACGILLIVRAY's „variety", on the ground that *Triphyllozoon umbonatum* (*Retepora umbonata* Buchn.) is a name which properly belongs to the Japanese material described and figured by BUCHNER, and that this is not MACGILLIVRAY's variety. *R. umbonata* seems to me a probable synonym of *T. bimunitum*, as shown by the characters of its peristomes and ovicells, and particularly by the form of the large mandibles figured by BUCHNER (text-fig. U, *b*, *c*, p. 207); these having a strong resemblance to the large fenestral mandibles of some of the Siboga specimens (cf. Pl. XLI, fig. 12, *a*) which I have referred to *T. bimunitum*. I have not, however, found large bicuspid infrafenestral avicularia exactly like that shown by BUCHNER in Pl. XVII, fig. 7). *Triphyllozoon magniscutulatum* Canu and Bassler, 1929, is another possible synonym.

In view of the uncertainty of my determinations and synonymy, it is necessary to add notes on the individual specimens here recorded as *T. bimunitum*.

The typical form is represented by a specimen in the Cambridge collection from the original locality (Japan). The fenestrae are small, not quite reaching 2 mm. in length. The young zooecia are strongly tubercular frontally, the peristome much raised proximally and swollen on one side by the elongate labial avicularium, which terminates at the proximal margin of the secondary orifice in a minute rounded rostrum facing frontally. A small avicularium, round or oval, occurs here and there, specially in the margins of the fenestrae. The large marginal avicularia are directed proximally and face frontally, not more than one usually occurring in a fenestra. They are widest at the region of the calcareous bar, then narrowing and expanding a little at the rounded end, which has two strong vertical cusps. ORTMANN was probably mistaken in describing the mandible as rounded distally. It is acute and narrow in my Japanese specimen (Pl. XLI, fig. 4, *c*, *d*) as in those of the Siboga; but it is expanded near its distal end, then becoming decurved and passing between the two cusps of the rostrum, which it exceeds in length. The basal surface is tubercular, like the other surface, and has a few avicularia, apparently a long form of the oval type.

184. A differs from most of the others in the large size of its fenestrae (Pl. XXXV, fig. 39), which are elongate, about 3 × 1—2 mm. Except in its larger fenestrae it agrees with BUCHNER's var. *trimunita*. The large avicularia (Pl. XLI, fig. 1) are sometimes present on nearly every marginal zooecium. They are almost longitudinal, commencing in advance of a peristome, passing proximally in close contact with its outer side (as in other specimens) and facing frontally or laterally. They agree in form with those of the Japanese specimen; the expanded distal end having two very strong vertical cusps. The mandible (fig. 3, *f*—*h*) is wide, just

before its narrow decurved distal end. Many of the small frontal avicularia are of the oval kind with an occasional blister-like round avicularium. These two small types may be numerous, forming conical projections into the frontal parts of the fenestrae, especially in regions where there are no large avicularia. The basal surface of old trabeculae (fig. 2) has exceptionally numerous avicularia, among which are large bicuspid ones, like the marginal avicularia, forming mound-like swellings bearing horizontal rostra. Some have vestigial cusps and these are the "sole-like" avicularia shown by BUCHNER in Pl. XVII, fig. 2. Both the small kinds are profusely developed, the oval ones varying in size and shape, often expanding distally. The round avicularia are blister-like, the palatal surface being on one side of the apex of the mound, but with no constant orientation The ovicells (fig. 1) are usually more mucronate than in 111. G (fig. 8), the edge of the descending lamina slightly concave, sometimes with a small median emargination, the labellum being hardly represented.

In 111. G also the numerous marginal avicularia are directed proximally, but they face the fenestrae, into which their rostra project freely, so that they are seen edgeways in frontal view (Pl. XLI, fig. 8). Their mandibles are not widened near the distal end (fig. 11). The small frontal avicularia are excessively numerous, as is the case with the older parts of the basal surface (text-fig. 41, A); many being here in process of occlusion, giving rise to projecting conical tubercles. In this, as in other specimens, although the rostrum of the small avicularia is immersed, the proximal end is much raised vertically and in those suitably placed projects into the fenestra. The peristomes, spines, labial avicularia (text-fig. 41, B) and ovicells are typical.

112. F and 113. A, from the same Station as 111. G or an adjacent one, have specially large fenestrae. The large marginal avicularia are smaller than usual, and some are directed distally, their mandibles (Pl. XLI, fig. 13, *e*) being correspondingly small. In addition to many of these, 112. F has an extraordinary profusion of small frontal avicularia, the sides of the trabeculae being studded with numerous conical projections formed by them. The basal surface is also well provided, including many large horizontal avicularia of the bicuspid type, but with reduced cusps, as is usual in other species in which avicularia of this kind occur basally.

In 108. B horizontal bicuspid marginal avicularia are common and conspicuous, usually 1—3 in a fenestra, directed obliquely proximally and facing frontally. They are large, with very strong cusps, which are closely approximated at their base, so that in end view they appear V-shaped, and the cusps may be recurved. The mandibles are shown in Pl. XLI, fig. 7.

144. A is a beautiful young colony, with well preserved spines (Pl. XLI, fig. 5) as described on p. 617, the fenestral avicularia with specially long and prominent cusps, their mandibles (fig. 12, *a*) decurved and projecting far beyond the rostra. Their efficiency is shown by the fact that one of them is grasping a tapering tube, as long as a zooecium, perhaps belonging to a Pteropod. The end of the mandible passes over it and holds it firmly between the two cusps of the rostrum. The labial suture is rather longer than usual and the labial pore is pointed distally. The general basal surface has no large avicularia, the small ones being confined to the edges of the fenestrae.

32. A has the usual bicuspid fenestral avicularia, greatly swollen, horizontal, directed proximally, facing frontally; not more than one occurring in a fenestra.

The operculum of var. *sparsimunita*, as figured by BUCHNER (text-fig. T, p. 206), is

longer than wide; but it is questionable whether this variety belongs to *T. bimunitum*. The opercula here considered have a strong marginal sclerite. Those from the type-locality (Pl. XLI, fig. 4, *a*, *b*) are markedly smaller than those of the Siboga (figs 3, *a*; 13, *a*, *b*). The fenestral mandibles show a considerable range of variation. Those from Japan (fig. 4, *c*, *d*) are widened and produced into two lateral lobes in their distal half, the apex being moderately or strongly decurved. These lobes appear to represent the lateral leaves of the trifoliate mandibles of *T. indivisum* and *T. trifoliatum*. They are well marked in 184. A (fig. 3, *f*—*h*) and are indicated in the specially large mandible of 144. A (fig. 12, *a*) and in some mandibles of 108. B (fig. 7, *c*); *a* in this specimen having straight or slightly curved lateral margins with no trace of the lobes; *b* in this figure probably belongs to a basal avicularium. 112. F has a relatively wide fenestral mandible (fig. 13, *e*); but in 111. G from the same Station (fig. 11, *a*—*d*) they are much narrower; none of the mandibles from this Station being lobed. It seems obvious that a strongly decurved mandible like fig. 4, *d* could not occur in an avicularium of the completely immersed type; but must belong either to one with its distal end projecting into a fenestra or to a frontal or basal avicularium the end of which stands up far enough to allow the mandible to close completely.

10. *Triphyllozoon mucronatum* (Busk) (Pl. XXXV, fig. 35; Pl. XL, figs 13—20; text-fig. 42).

Retepora mucronata Busk, 1884, Chall., p. 120, Pl. XXVI, figs 6, *a*—*e*. Philippine Is., 18 fath.
Triphyllozoon moniliferum Canu and Bassler, 1929, BPR, p. 374, Pl. L, figs 1—6. Philippine Is., 57 fath. (nec *Retepora monilifera* MacGill.).
? *Triphyllozoon biseriatum* Canu and Bassler, ibid., p. 372, Pl. XLVIII, figs 9—12. Phillippine Is., 57 fath.

Group B. 90. A. Stat. 117. Kwandang Bay, N. Celebes, 80 M. 1 col.
483. A. Stat. 117. Kwandang Bay, N. Celebes, 80 M. Fragments.
Group C. 133. A. Stat. 164. W. of N. end of New Guinea, 32 M. 3 col.
279. F. Stat. 250. Kur Id., Kei Is., 0—45 M. Fragments.
177. G. Stat. 257. Kei Is., 0—52 M. Fragments.
177. H. Stat. 257. Kei Is., 0—52 M. 1 young col.

British Museum: —

Philippine Is., 18 fath. 'Challenger' Col. 87. 12. 9. 496 and 99. 7. 1. 3141 (BUSK's type-slides).
Philippine Is., 57 fath. CANU and BASSLER Coll., 31. 12. 30. 138 (as *Triphyllozoon moniliferum*).

The Siboga Stations are all near the type-locality.

Zoarium (Pl. XXXV, fig. 35) saucer-shaped, expanding as a wavy lamina or becoming subtubular and infundibuliform, with internal orifices. Fenestrae moderate, generally wide oval; trabeculae narrow, 2 to 3 or 4 serial. Labial pore moderate or small, near the edge of the peristome, which is typically (but not always) cusped proximally by the projecting labial avicularium. Large fenestral avicularia of three kinds: — (*a*) munitiform (text-fig. 42 A, *M. av*), generally suprafenestral, the orifice small, narrow, transverse or longitudinal; occurring also on the frontal surface of zooecia which are not marginal; (*b*) large triangular (Pl. XL, fig. 14, *b*), sometimes immense, greatly raised and subconical, with acute rostrum without definite cusps; (*c*) large infrafenestral (fig. 14, *c*), belonging to the same type as the *b* avicularia; and, like them, with a rostrum decurved distally, its margins finely denticulate, without cusps; the mandibles in both cases acute. Small round or oval and large, triangular avicularia may be numerous frontally.

Ovicells not mucronate, small, some projecting into the fenestrae, the arms of the stigma subequal, or the median arm the shortest, the lateral arms nearly straight and widely diverging. Basal surface (text-fig. 42, B) with very long, narrow, nearly horizontal and parallel-sided, immersed avicularia, narrowest at the extreme distal end. Small avicularia, on the general basal surface as well as in the fenestrae, rare or numerous.

In most cases the fenestrae are rather large, subcircular or oval, and wider than the trabeculae; but smaller fenestrae and wider trabeculae may be found. The peristome is usually internally denticulate proximally, and the labial avicularium has a small, rounded rostrum and

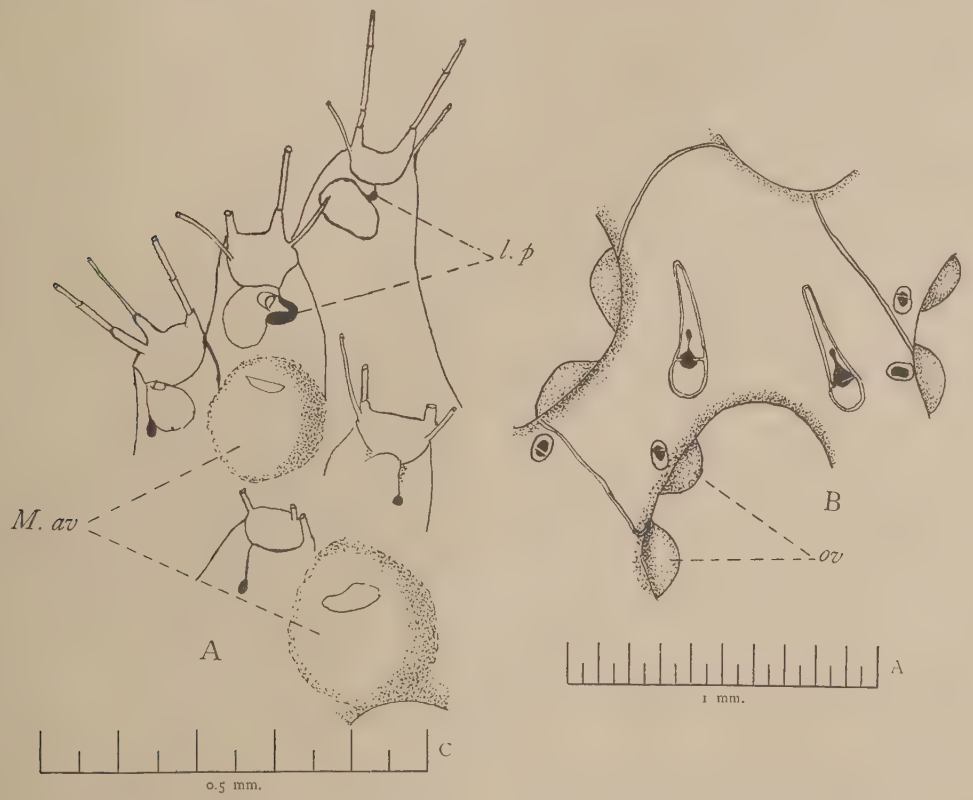

Fig. 42. — *Triphyllozoon mucronatum*. — A, 483. A¹. Growing margin; *l. p*, labial pores; *M. av*, munitiform avicularia. Obj. C. — B, 177. G². Basal surface; *ov*, ovicells. Obj. A.

mandible. Spines are well developed in the young state (see below) but are generally at most represented by bases, 1 : 1. The basal surface (old) is strongly tubercular, the vibices stout, mainly oblique or transverse, the large avicularia at first raised, later immersed.

T. mucronatum is often recognizable with difficulty, since most specimens possess but few of its distinguishing features. The large basal avicularia (text-fig. 42, B), found in all the Siboga specimens, seem to be its most constant character and are specially valuable as a recognition-mark. The long narrow rostrum, diminishing regularly to its distal end, is in marked contrast with that of certain other species. The "long and thin" basal avicularia mentioned by Canu and Bassler (1929, p. 372) in *Triphyllozoon biseriatum* suggest that this species is a synonym of *T. mucronatum*. The small oval avicularia on the general basal surface, not restricted to the margins of the fenestrae, are also characteristic.

Three kinds of large fenestral avicularia may occur; but unfortunately it it seldom possible to find more than one or two of them in the same colony. It is thus an important fact that a single small fragment of 483. A includes them all; and this, with other parts of the same colony, combines most of the characters which seem to be distributed at random among the other specimens. The peripheral zooecia (text-fig. 42, A) of this young colony have a completely tubular peristome, the distal wall of which is high (an unusual feature in *Triphyllozoon*), flat and sharply truncate. At each of its lateral borders there are two long, moderately stout, diverging spines, jointed and apparently derived from a common base which divides just above the truncate plate forming the distal end of the peristome, the proximal border of which has a straight, denticulate edge internally (Pl. XL, fig. 14). The labial pore (text-fig. 42. A, *l. p*) is moderately large, and the labial suture is rather longer than usual. On one side of it the labial avicularium may rise as a strongly projecting cusp; and in one instance it is munitiform. The tubercular convex surface of the zooecia, which are limited by thin and indistinct septal lines, rises gradually to the cusp. Several zooecia have, frontally, a swollen unilateral munitiform avicularium (*M. av*) with a transverse biconvex orifice; and one of these is suprafenestral. In an adjacent fenestra there is a munitiform avicularium with a longitudinal orifice; and one or two zooecia have a small raised avicularium of the round type, on their fenestral side, near the base of the peristome, or proximally, or in both positions. On the proximal side of the most peripheral fenestrae the number of these small avicularia is increased; and a zooecium may have as many as 5, each independently projecting and forming a cusp resembling those of the labial avicularia, but rather smaller. An everted polypide in this neighbourhood had died with 8 tentacles spread out in such a way that their number could be counted with certainty.

In another fragment of the same colony (Pl. XL, fig. 14), one fenestra has avicularia of two types; — *b* (see diagnosis) immense, acute, suprafenestral, its rostrum facing frontally and directed obliquely proximally; *c*, infrafenestral, inflated, facing the fenestra and directed nearly transversely, its distal end reaching the middle line; and sometimes, in addition, a similar avicularium with the same orientation but situated laterally, on the other side of the same fenestra. A neighbouring fenestra, also with 2 *c* avicularia, has a suprafenestral munitiform avicularium. A young ovicell in which the stigma is not yet fully formed is shown in Pl. XL, fig. 15. The proximal wall was obviously broken on the left side.

Older fragments of the same slide show similar *b* avicularia, but none of the *c* type; while munitiform avicularia were found with difficulty. The basal surface is strongly vibicate, with a typical long avicularium and a moderate number of small oval avicularia with raised edges. The labial avicularia mostly face frontally, and the proximal margins of the peristome are then not cusped; and many of the small avicularia are of the oval type, in addition to round ones. 483. A gave valuable information with regard to the infestation of Reteporidae by Hydroids (see p. 530).

The remaining specimens were determined with the aid of the clues given by 483. A. 90. A (Pl. XXXV, fig. 35) was a colony 35 mm. across and 25 mm. high, and it had become tubular at a short distance from its base, then expanding into a wide subtubular lamina. No proximal denticulation of the peristome was observed, nor could munitiform avicularia be found. Gigantic suprafenestral avicularia of the *b* type are present, agreeing with those of 483. A.

Small frontal avicularia are exceptionally numerous, giving this specimen an appearance quite different from that of the others. This unusual condition was possibly correlated with its infestation by *Hippothoa* (see p. 531), numerous secondary avicularia having perhaps been produced in a vain attempt to prevent the overgrowth. Two ovicells, one of which had not completed its stigma, are shown in Pl. XL, fig. 17.

Munitiform avicularia are frequent in 177. H, the only other specimen in which they have been seen. They occur suprafenestrally and elsewhere on the frontal surface, the slit-like orifice being either longitudinal or transverse.

177. G, from the same Station, is old, much altered by secondary calcification. None of the three types of large avicularia were found fenestrally, but there are many of the triangular *b* type on the general frontal surface, varying in size but some large. They are mainly immersed, the rostrum slightly ascending, decurved distally, with a somewhat projecting free apex. The basal surface (text-fig. 42, B) is well provided with long immersed avicularia.

279. F (Pl. XL, fig. 13) is younger, in general like 177. G, but with a large number of similar frontal avicularia. A few of those deeply situated on marginal avicularia may be fenestral, resembling those of 483. A, in some instances with a faint indication of the denticulate edges of that specimen. *H* is a Hydroid orifice, communicating with an open groove. In contrast with 279. F, 133. A has very rare avicularia of the above type, but one at least is infrafenestral.

T. mucronatum has not, I believe, been redescribed under this name since its original introduction; and the account then given was insufficient to make its recognition easy. BUSK's type-material was scanty and is not very satisfactory. I attach special importance to the fact that his slide 87. 12. 9. 496 shows a munitiform avicularium like those of the Siboga specimens, the ovicells of which agree completely with those of his material. The "small pore" BUSK described on the ovicell is doubtless one of the small avicularia commonly present on the ovicells of this and other Retepores. I have not found the "anterior" (frontal) avicularia shown by him in fig. 6, *e*; but the figure corresponds with the large basal avicularia present in all the Siboga specimens; and perhaps BUSK was mistaken in describing it as frontal. A labial avicularium can be found in many of the old zooecia of the Siboga material (*contra* Busk), though sometimes with difficulty.

On the evidence of a specimen presented to the British Museum by CANU and BASSLER and from the locality indicated by them (1909, BPR, p. 374), I have included *T. moniliferum* CANU and BASSLER in my synonymy of *T. mucronatum*. There seems to have been no valid reason for the determination made by these authors. The "long thin avicularia" mentioned in their explanation of Pl. L, fig. 5 (basal surface), one of which appears in the figure, are specially characteristic of *T. mucronatum*, as are the "small poriform avicularia" mentioned in their explanation of fig. 6, also a basal view. The relatively large fenestrae and the antenniform spines mentioned in the text also agree with what I have found; although I should describe the spines of 483. A as merely well jointed, but with the distal ends of the segments hardly expanded and therefore not typically antenniform.

Retepora cornuta Ortmann (1889, JB, p. 35), properly *Triphyllozoon cornutum*, from Japan, 40—150 fath., is probably allied to *T. mucronatum*, though distinct from it, on the evidence of the mucronate ovicells. ORTMANN figured munitiform avicularia (Pl. I, fig. 27, *d*)

and I have found them in a Japanese slide (OWSTON Coll. 28. E) probably referable to ORTMANN's species, in the Cambridge collection. There is a small labial pore in this specimen and a single infrafenestral avicularium, not unlike those of *T. mucronatum*, except that its rostrum is bicuspid. The peristome is obscurely denticulate proximally, where it is hardly cusped by the small labial avicularium. The ovicells are distinctly mucronate, a feature to which ORTMANN's specific name refers, but there are no elongate basal avicularia. The large spatulate avicularia shown by ORTMANN (fig. 27, *e*) do not occur in the Cambridge slide.

My Canada balsam preparations are unsatisfactory, several of the specimens having been dead and not possessing a full complement of avicularia. 279. F (Pl. XL, fig. 19) is the most complete in this respect; the figure showing, in addition to the operculum (*a*), one of the long basal mandibles (*g*), two rather wide fenestral (*e*, *f*), an acute frontal of moderate size (*d*), a rounded labial (*h*) and two small round frontal (*b*, *c*), the larger of which is transitional to the munitiform type. A typical munitiform mandible, much chitinized and with strong sclerites, is shown in Pl. XL, fig. 20, *b*; the operculum (*a*) in this specimen (177. H) being rather larger and having a stronger marginal sclerite than in others, in which the opercula mostly have a weak sclerite. The fenestral mandibles of 483. A (fig. 16, *c*) seem to be narrower than those shown in fig. 19; but the side view in which they are seen is not suitable for an estimation of their width. 133. A has acute frontal mandibles (fig. 18, *b*, *c*), resembling those of 279. F.

11. *Triphyllozoon tuberculiferum* [1]) n. sp. (Pl. XXXV, fig. 37; Pl. XLI, figs 9, 10, 14—17; text-figs 43, 44).

Group B.		79. C. Stat. 105. Sulu Archipelago, 275 M.
		79. D. Stat. 105. Sulu Archipelago, 275 M.
	?	86. A. Stat. 105. Sulu Archipelago, 275 M. (old and worn).
	Type.	478. B. Stat. 107. Sulu Archipelago, 270 M.
Group C.	?	104. B. Stat. 139. W. of Halmaheira (Djilolo), 397 M. (old and worn).
		111. L. Stat. 156. W. of Waigeu Id., 469 M.
		111. M. Stat. 156. W. of Waigeu Id., 469 M.

The specimens are all fragments.

Zoarium (Pl. XXXV, fig. 37) expanding nearly in one plane. Fenestrae usually large, elongate rhomboidal; trabeculae narrow, 2 serial or 3—4 serial before a bifurcation. Labial pore closed, connected with the edge of the peristome by a labial suture of variable length; sometimes remaining as an open sinus. Spines generally represented at most by their bases. Large bicuspid fenestral avicularia wanting, except for the occasional projection of a frontal avicularium. Munitiform avicularia sometimes present, especially suprafenestrally or infrafenestrally. Large bicuspid avicularia usually found frontally and basally, in most cases forming prominent cones, the rostrum ascending obliquely or vertically to the apex. Small avicularia often excessively numerous in the older parts, both frontally and basally. Lateral arms of the stigma of the ovicell generally strongly curved.

This species resembles *T. bimunitum* in its zoarial form and in the excessive number of small avicularia found in certain specimens. It differs from it in the absence of typical

1) In allusion to the large conical avicularia of both surfaces.

bicuspid fenestral avicularia, in the occurrence of munitiform avicularia and of large cone-like frontal avicularia, as well as in the usually curved lateral arms of the stigma of the ovicell.

The fenestrae are generally about 2 × 1 mm. The young zooecia are elongate (text-fig. 43), parallel-sided, with distant small tubercles and inconspicuous septal lines. The peristome (Pl. XLI, fig. 15) is slightly raised proximally, where it is denticulate, and laterally, its external angle at first projecting into the fenestra. The labial pore is usually closed, its suture slightly carinate and prolonged into a short wide labial tube, visible in young zooecia. A deep sinus occasionally persists even at a distance from the growing margin (478. B). In young zooecia

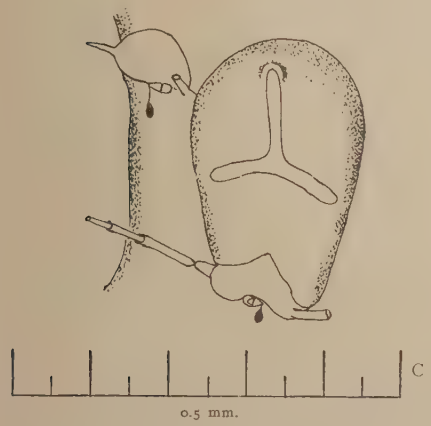

Fig. 43. — *Triphyllozoon tuberculiferum*. 79. C[1]. Young peristomes and ovicell. Obj. C.

the labial avicularium may form a conspicuous inflation of one side of the peristome, appreciably projecting on its edge. Spines (text-fig. 43), 1 : 1, are usually represented at most by their bases, but are more numerous, occasionally long and antenniform, in young zooecia. 478. B, although young, has merely spine-bases, 2 or perhaps 3 external ones being visible in some zooecia.

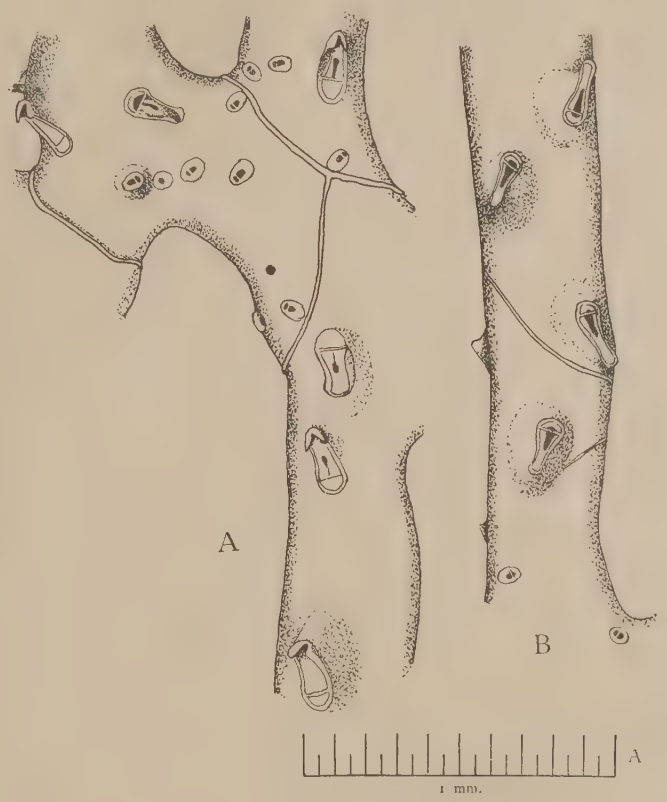

Fig. 44. *Triphyllozoon tuberculiferum*. — Basal surface, Obj. A. A, 79. D[1]. — B, 111. L.

The frontal avicularia are variable in number, few or excessively numerous, and in form. The specimens from Stat. 105 might be taken, at first sight, to belong to more than one species, but they form a practically continuous series from rarity to plenty and from a subhorizontal to a vertical position of the large avicularia. Large acute avicularia (Pl. XLI, fig. 17), often greatly raised distally, with narrow mandibles, are characteristic. In 478. B they are median or unilateral, forming conspicuous mounds covering most of the frontal surface of the zooecia and occurring on a large proportion of them, or even on a ovicell. The short rostrum slopes up to the raised distal end, which is strongly bicuspid, the bases of the cusps almost touching in the middle line, their points being slightly recurved. Their orientation is either proximal or distal, and most of them face obliquely frontally, though a few are nearly vertical. Those of

certain zooecia project strongly into the fenestrae, usually with an obliquely proximal direction (Pl. XLI, fig. 16). In 79. C the rostrum, in some of the bicuspid avicularia (fig. 10), rises vertically to its narrow apex or is so much decurved distally that its palatal surface faces the frontal side of the trabecula. Small avicularia are specially numerous in 478. B, those of the round type being interesting in showing a complete series of transitions from the small kind with a subcircular palatal surface in which the mandible is wider than long (fig. 14, *c*, *d*) to the greatly enlarged munitiform type. Many of these are mound-like in 478. B, varying in size from small to large; the largest being suprafenestral (Pl. XLI, fig. 17, *M. av*), with the strong, brown mandible characteristic of this type. Occasional oval avicularia occur on the frontal surface.

The arms of the stigma of the ovicell (fig. 17) are about equal in length, the lateral arms generally much curved inwards, the median arm terminating in a more or less definite mucro. The free edge of the short labellum may be emarginate and the orifice of the fertile zooecium is normal; a feature in which this species differs from *T. separatum* (see p. 630). In 79. C. the ovicells are smaller than usual and the lateral arms of the stigma are not certainly curved (text-fig. 43).

The basal surface (text-fig. 44) has avicularia like those of the frontal surface, the small ones being sometimes excessively numerous. In 79. D (text-fig. 44, A) the vibices are strong. There are many large bicuspid avicularia, variably raised distally. Small oval avicularia are very numerous, rather larger than in most other species, occurring especially at the margins of the fenestrae. In 79. C, from the same Station, large vertical avicularia, like those of the frontal surface, are found basally, with many small avicularia. In 111. L (text-fig. 44, B) the large avicularia, which are hardly bicuspid, are mound-like, with long narrow rostra and are arranged with some regularity. Small avicularia are rare in this specimen.

The opercula of 79. D (Pl. XLI, fig. 14, *a*, *b*) are evenly rounded or, more frequently subquadrangular; and they differ from all other species of *Triphyllozoon* examined, with the exception of *T. punctiligerum* (see p. 628) by being so strongly chitinized throughout that the marginal portion is no thicker than the rest and is not distinguishable as a sclerite. The small round mandibles (*c*, *d*) are all specially wide in proportion to their length, the distal margin being finely toothed. A large mandible (*e*) is very acute, wide proximally and in its distal half. The mandibles figured were not *in situ* but were probably frontal.

The opercula of 79. C (Pl. XLI, fig. 9, *a*, *b*) are markedly different from those of 79. D (fig. 14, *a*, *b*) from the same Station, in their form and in the presence of a distinct marginal sclerite. I at first regarded the differences as specific, but the evidence of the large frontal and basal avicularia is against this conclusion. 79. C is a young specimen, and the differences from 79. D may be a question of age.

12. *Triphyllozoon patulum* [1]) n. sp. (Pl. XXXV, fig. 36; Pl. XLI, figs 19—21; text-fig. 45).

Group A. 466. B. Stat. 59. Samau Strait, W. Timor, 390 M. Fragment, old, dead.
Group C. Type 187. A. Stat. 267. Kei Is., 984 M. Several fragments.

Zoarium (Pl. XXXV, fig. 36) expanding nearly in one plane. Fenestrae elongate, inconstant

1) In allusion to the wide mandibles of the large avicularia.

in form and size, frequently rhomboidal, wider than the trabeculae and sometimes exceptionally large. Trabeculae narrow, 2—3 serial. Labial pore small, opening into a labial tube; labial suture short; labial avicularium usually wanting. Frontal avicularia numerous, very large, horizontal; the rostrum wide, its sides slightly incurved, semicircular distally; the mandible of the same form, thin, without teeth. Primary ovicell not mucronate, with very minute and numerous tubercles, the median arm of the stigma the longest, the lateral arms not strongly incurved. Secondary calcification results in the occlusion of parts of the stigma, especially of the lateral arms. Large basal avicularia like those of the frontal surface.

It is possible that this is a form of the Japanese *Triphyllozoon punctiligerum* (*Retepora punctiligera* Ortmann, 1889, JB, p. 35; Buchner, 1924, UJR, pp. 168, 203); but, as explained below, the opercula from Japan differ so markedly from those of 187. A that this seems improbable. The Siboga specimens are larger in all their parts than in one from Japan (200 fath., Mus. Cambridge [1]) Owston. Coll. 63. G) which appears to be Ortmann's species. Ortmann did not describe large avicularia in *T. punctiligerum*, nor have I found them in the specimen from Japan; but Buchner stated that they occur in material from that locality. Okada (1920, RAJ, p. 620) also found *T. punctiligerum* off Japan, 60—200 fath. He commented on the variation in size and shape of the fenestrae; — characters which he regarded as of not much specific importance. He described the compensation-sac, a structure which has been seldom actually observed in Reteporidae. Miss Robertson's record (1921, BBB, p. 59) of *R. punctiligera* in shallow water in the Bay of Bengal is not confirmed by either a description or a figure.

The Siboga specimens are mostly 2—3 serial, but a trabecula is rarely uniserial. The young zooecia are specially long and slightly convex, outlined by strong septal ridges; in the earliest stages smooth and hyaline, but soon becoming covered by numerous small tubercles, not in contact with one another as they are in the Japanese material. The tubercles are later obliterated by a thick, smooth porcellanous crust. The young peristomes are raised proximally, not denticulate internally, the orifice facing obliquely distally, the margin plain or sometimes produced into a short point laterally. The edge of the labial pore may be slightly raised, a feature to which Buchner alluded in his account of *T. punctiligerum*, and the short labial suture is more or less carinate. An open sinus has been found in immature zooecia (rarely in those which are complete) and was obviously closing to form a labial tube. Spine-bases are rarely indicated, but in one instance 2 outer ones occur on a marginal zooecium.

The characteristic large avicularia (Pl. XLI, fig. 20), present on many of the zooecia, are generally unilateral, commencing near the peristome and directed proximally, with varying degrees of obliquity, or directed distally. Two may occur on a zooecium, at different levels. They are completely horizontal, the rostrum having thin edges with no indication of cusps. Some, on the more low-lying parts of marginal zooecia, are fenestral. They vary in size and may be hardly larger than the small oval avicularia, of which they are probably a modification. Unmodified oval avicularia are not common frontally. Small round avicularia are also infrequent here, but when present they may be so much enlarged as to be practically munitiform.

The near affinity of *T. patulum* to *T. punctiligerum* is shown by the ovicells. According

1) Transferred to the British Museum.

to BUCHNER, illustrated by his text-figure on p. 169, the lateral arms of the stigma of *T. punctiligerum* are variable and are often wanting or partially suppressed; a result due to the occlusion, partial or complete, of the stigma by later calcification.

The primary ovicell of *T. patulum* is thin-walled, as in other Reteporidae. I have not found the earliest stages, but a young ovicell (text-fig. 45, A) has a trifoliate stigma, one of the lateral arms being irregular, and was becoming covered at the sides by overgrowths (*sec. c*), from the adjacent zooecia, which just reach the stigma. By a continuation of this process (text-fig. 45, B) the ovicell becomes almost completely covered, and the originally trifoliate stigma is reduced to the condition shown by BUCHNER in his text-figure. Precisely similar changes occur in the Japanese specimen of *T. punctiligerum* (text-fig. 46), drawn to the same scale as fig. 45. The size of the ovicells is very different in the two species, and their descending laminae and associated

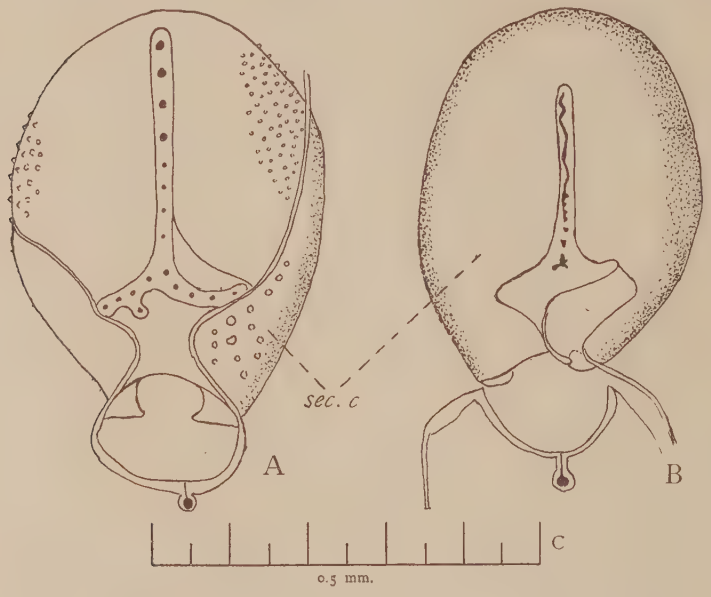

Fig. 45. *Triphyllozoon patulum.* — Illustrating the overgrowth of the ovicell by secondary calcification (*sec. c*) from the adjacent zooecia. — A, 187. A[1]. Young ovicell with numerous papillae, showing the trifoliate stigma. Obj. C. — B, Same slide. Old ovicell in which the lateral arms of the stigma are occluded, surface smooth. Obj. C.

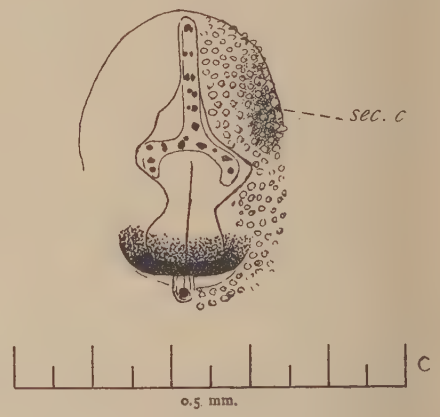

Fig. 46. *Triphyllozoon punctiligerum.* Mus. Cambridge, Japan, 63. G[1]. Ovicell, almost covered by secondary calcification (*sec. c*). Obj. C.

parts do not agree in form. The ovicells are not mucronate in either species and their tubercles are larger in *T. punctiligerum.*

The basal surface of *T. patulum* is tubercular, like the front, and the vibices (Pl. XLI, fig. 19) are strong and prominent. A moderate number of small oval avicularia are here present, specially near the margins of the fenestrae, into which their raised proximal ends may project as small conical papillae. An occasional large avicularium, like those of the front, occurs basally.

The opercula of *T. patulum* (Pl. XLI, fig. 21, *b*, *c*) are so strongly chitinized that the proximal margin is distinct; — an unusual condition in *Triphyllozoon*. They are narrower distally and a marginal sclerite is present. The spatulate mandibles (*e*—*i*), of great size, vary much in form, some being hardly larger than the small oval mandibles. Although well chitinized, they are so thin that their margins often become infolded when mounted. The mandibles (*a*) of the small round avicularia are much wider than long, and those (*d*) of the oval ones are shorter than in most of the other species.

The opercula of *T. punctiligerum* (Pl. XLI, fig. 18, *a*, *b*) are even more strongly chitinized,

the proximal margin being distinct and sometimes subsinuate. They differ from those of *T. patulum* in their size and shape; — being smaller and not narrow distally; — and in the fact that the chitin is everywhere so thick that no marginal sclerite is differentiated. In the latter respect they agree with the opercula of *T. tuberculiferum* (see p. 626).

13. *Triphyllozoon separatum* [1]) n. sp. (Pl. XXXV, fig. 38; Pl. XL, figs 21, 22; text-fig. 25, G, p. 519; text-figs 47, 48).

Group C. Type III. F. Stat. 156. W. of Waigeu Id., 469 M. Fragments.

Form of zoarium (Pl. XXXV, fig. 38) not ascertained. Fenestrae large, elongate, rhomboidal (as much as 3 × 1 mm.; trabeculae moderate, 2—3 serial, the median zooecia commonly

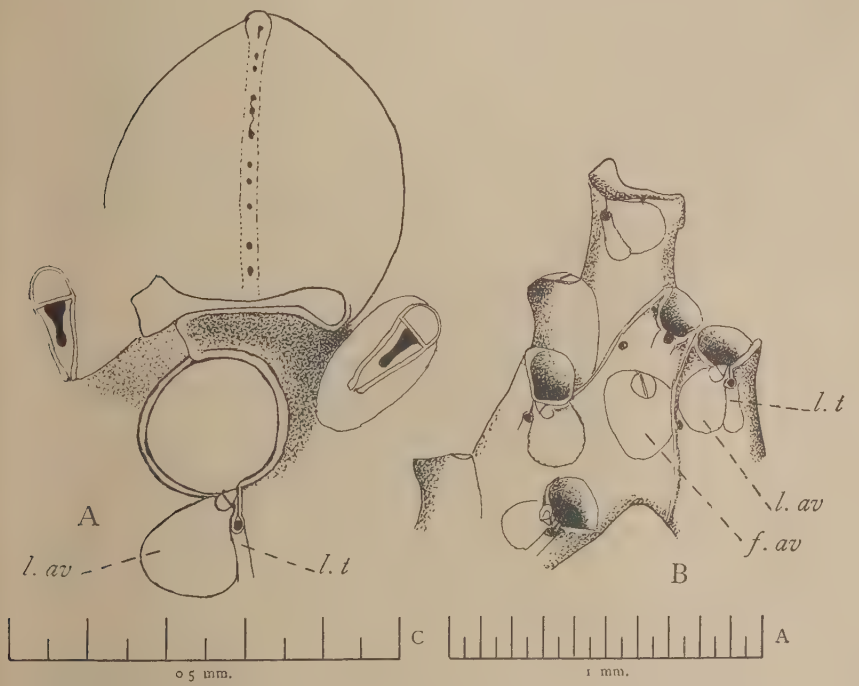

Fig. 47. *Triphyllozoon separatum.* — A, III. F[1]. Old ovicell, the lateral arms of the stigma occluded. Obj. C. — B,. same slide. Growing margin; *f. av*, frontal avicularium; *l. av*, labial avicularium; *l. t*, labial tube. Obj. A.

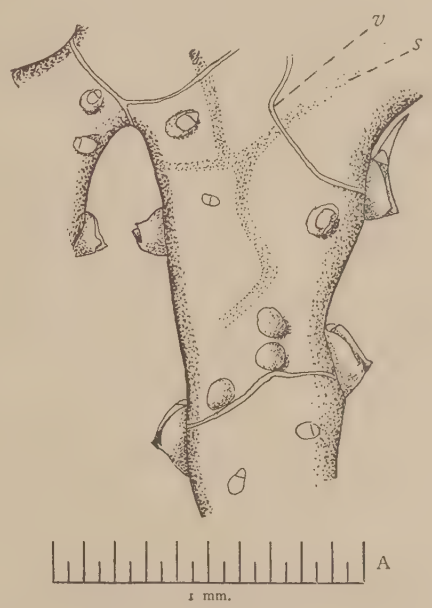

Fig 48. *Triphyllozoon separatum.* — III. F[1]. Basal surface. The basal parts of the septal walls (*s*) separating the zooecia are visible through the semitransparent basal kenozooecia; *v*, vibex. Obj. A.

with ovicells. Young peristomes long, nearly in line with the frontal wall, so that the secondary orifice faces almost distally. Labial pore small, near the edge of the peristome, continued into a long labial tube (text-fig. 47, B, *l. t*) running along its frontal wall; an open sinus occurring in fertile zooecia and occasionally in others. Labial avicularium exceptionally large, forming a conspicuous swelling on the peristome. A large descending avicularium projects from nearly every marginal zooecium, its rostrum more or less bicuspid, directed obliquely proximally into the fenestra, which it faces. Similar avicularia, mostly with a proximal orientation, are common on the frontal surface, where they form subconical mounds. Ovicells not mucronate, longitudinally

1) Referring to the separate, tubular orifice of the fertile peristome.

carinate, later separated from the orifice by a secondarily produced distal peristomial wall, resulting in the formation of a tubular, almost Cyclostome-like secondary orifice.

This interesting species may be recognized by the unusual modification of the fertile secondary orifices (Pl. XL, fig. 22), by the great abundance and prominence of large frontal and marginal avicularia and by the large size of the labial and other avicularia.

The zoarium probably consists of flat lobes; the fenestrae being large and much wider than the trabeculae. These are usually at first 2 serial, often becoming 3 serial half way up the fenestra, and again biserial after the bifurcation. Septal lines are generally indistinct or only partially present except at the growing edges, but they may be simulated by secondary frontal vibices which do not correspond with them. The young zooecia (text-fig. 47, B) are vitreous, thick-walled, wide, moderately long, the lateral margins parallel, the surface smooth or very slightly tubercular frontally. They become opaque, white and porcellanous, smooth or slightly tubercular, in the old state.

The labial avicularia (text-fig. 25, G. *av*, p. 519; text-fig. 47 B, *l. av*) are so large as to form conspicuous subconical swellings on the frontal surface. These have a general resemblance to the mounds of the large frontal avicularia (Pl. XL, fig. 22), which are generally lateral. The surface is thus nearly covered by swellings. Some of the marginal zooecia are wide enough proximally to carry an avicularium on each side, both of which may be directed obliquely proximally and away from the middle line of the zooecium. The inner of these two remains as an ordinary large frontal avicularium, with a triangular acute rostrum sloping up to the raised apex. The outer one, which is often in contact with the preceding peristome, projects beyond the zooecium, descending obliquely and proximally into the fenestra, the edge of which thus appears serrate (text-fig. 48), the apex of the rostrum being at about the level of the general basal surface. The marginal rostra are decurved terminally, where they are more or less definitely bicuspid, the two cusps closely approximated. The mandibles of all these large avicularia are acute (Pl. XL, fig. 21). Small round and oval avicularia are rare in parts where large ones occur, but they are to be found elsewhere in greater numbers. Those of the round type may be much enlarged and more or less munitiform (text-fig. 47. B, *f. av*).

Ovicells are shown in Pl. XL, fig. 22 and text-fig. 47. A. In the youngest stage found (represented by two examples) the primary ovicell is distinctly longer than wide, with a marked carina, corresponding with the median arm of the stigma and extending round the distal raised part of the ovicell, nearly to the point where its wall meets the frontal surface. In both, the peristome has acquired its unusual character, which is curiously like that of *Sertella cyclostoma* (see p. 565). Proximally it is sinuate, the sinus ending close to a normal labial pore, the labial tube connected with which is distinctly seen through the vitreous skeleton. Except for its sinus the peristome is a complete tube with a simple even margin. Distally its wall is continuous with a calcareous layer covering part of the ovicell and ending abruptly in a transverse line which corresponds with the lateral arms of the stigma (text-fig. 47. A). In certain older ovicells similar arrangements are found, except that the peristome may have a median interruption distally. The secondary peristomial tube is developed from two halves, not always symmetrical, which may or may not unite distally (text-fig. 47. A). Their growth involves the laying down of a calcareous investment on the corresponding part of the ovicell. As in other Retepores,

this is an overgrowth from the frontal walls of adjacent zooecia. The primary ovicell, at first freely projecting, becomes thus immersed, and the oldest ones are embedded in a thick white calcareous crust which covers most parts of the trabeculae. The lateral arms of the stigma are certainly partially concealed by this overgrowth (as in *T. patulum*); and many if not all their pores may become thus occluded. It is possible that these arms are longer than they appear to be, and that their free ends are concealed by the overgrowth. The median arm is narrowed by the secondary calcification, but some at least of its pores remain visible (text-fig. 47. A).

The basal surface (text-fig. 48) has small, distant tubercles when moderately young. Somewhat later it is very irregular, owing to the immersion, complete or incomplete, of the small avicularia, which become relatively large conical tubercles, as commonly occurs in other Reteporidae. In a still older state the branch becomes entirely smooth on its basal surface. No large avicularia have been found here, and the small avicularia seem to be all of the oval type. They are evenly distributed on the surface of certain young trabeculae; in rather older ones being most frequent near the edges. In a still older state the small avicularia are restricted to the margins of the fenestrae, where they occur at some distance from the general basal surface, their upstanding proximal edges projecting into the fenestrae. There can be no doubt that these differences are due to the occlusion of some of the avicularia, and particularly those on the most exposed median regions of the trabeculae, by secondary calcification.

The material has not been large enough to allow chitinous parts to be isolated, but the outlines of some of the mandibles (Pl. XL, fig. 21) can be well seen in the dry slides.

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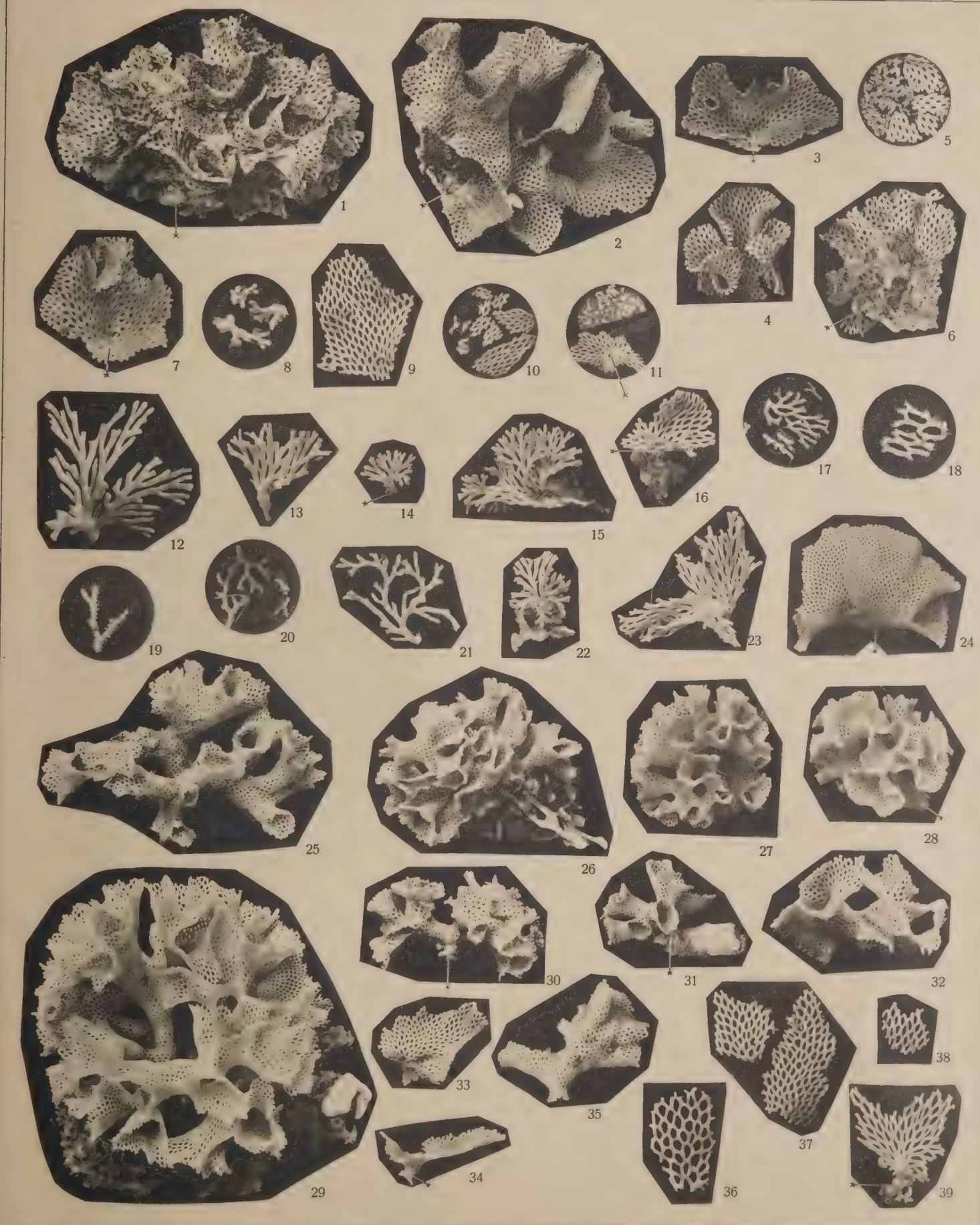
PLATE XXXV

ZOARIA.

All the figures are natural size. A cross indicates the position of the basal plate, if this is visible.

Fig. 1. *Iodictyum phoeniceum* (Busk) (p. 541). — Bass Strait, Type specimen, Brit. Mus. 99. 7. 1. 69. Carmine.
Fig. 2. *Iodictyum sanguineum* (Ortmann) (p. 546). — China Sea, Brit. Mus. 92. 1. 28. 109. Brownish purple.
Fig. 3. *Iodictyum willeyi* n. sp. (p. 544). — Lifu, Mus. Cambr. Frontal view. Dark purple.
Fig. 4. " " " — More convolute specimen, same locality. Bright pink.
Fig. 5. *Iodictyum deliciosum* nom. nov. (p. 554). — Japan, 44. A[1]. Mus. Cambr. Pink.
Fig. 6. *Iodictyum projectum* n. sp. (p. 550). — 271. A, Stat. 60, 303. Basal view. Pink.
Fig. 7. *Iodictyum buchneri* n. sp. (p. 552). — 100. A, Stat. 131, reef. Pale purple or violet.
Fig. 8. *Iodictyum spicatum* n. sp. (p. 555). — Torres Straits, Brit. Mus. 33. 11. 10. 1. Pink carmine.
Fig. 9. *Iodictyum perarmatum* n. sp. (p. 561). — 111. E, Stat. 156. Incomplete, frontal view.
Fig. 10. *Iodictyum gibberosum* (Buchner) (p. 559). — China Sea. Brit. Mus. 33. 11. 10. 2.
Fig. 11. *Iodictyum polycrenulatum* (Okada) (p. 556). — 177. D[1], Stat. 257.
Fig. 12. *Reteporella graeffei* (Kirch.) (p. 573). — 221. A, Stat. 305. Incomplete, basal view.
Fig. 13. " " " — 137. A, Stat. 164. Incomplete, frontal view.
Fig. 14. " " " — 137. A, Stat. 164. Complete, young, frontal view.
Fig. 15. " " " — 137. A, Stat. 164. Larger colony, frontal view.
Fig. 16. *Sertella granulata* (MacGill.) (p. 566). — 108. D, Stat. 144. Frontal view.
Fig. 17. *Sertella suluensis* n. sp. (p. 570). — 83. A, Stat. 105. Fragments, frontal view.
Fig. 18. *Sertella longifissa* n. sp. (p. 569). — 111. C[1], Stat. 156. Fragments, frontal view.
Fig. 19. *Reteporellina idmoneoides* n. sp. (p. 585). — 112. C, Stat. 156. Fragment, frontal view.
Fig. 20. *Reteporellina capistrata* n. sp. (p. 588). — 112. K[1], Stat. 156. Frontal view.
Fig. 21. *Reteporellina denticulata* (Busk) (p. 581). — 107. A, Stat. 144. Incomplete, frontal view.
Fig. 22. " " " — 358. A, Stat. 240. Young, frontal view.
Fig. 23. " " " — 358. A, Stat. 240. Older, frontal view.
Fig. 24. *Triphyllozoon hirsutum* (Busk) p. 594). — 193. C, Stat. 274. Mainly seen in basal view.
Fig. 25. *Triphyllozoon benemunitum* nom. nov. (p. 605). — 247. A, Stat. 310. Orifices on inner sides of tubes and funnels.
Fig. 26. " " " — 300. A, Stat. 273. On *Adeonella*.
Fig. 27. *Triphyllozoon philippinense* (Busk) (p. 597). — 65. A, Stat. 99. Nearly lateral view of a spheroidal colony. Orifices external.
Fig. 28. " " " — The same colony seen from the distal end.
Fig. 29. *Triphyllozoon inornatum* nom. nov. (p. 608). — 216. A, Stat. 285. Basally surrounded by a Keratose Sponge. Orifices internal.
Fig. 30. *Triphyllozoon tubulatum* (Busk) (p. 600). — 133. B, Stat. 164. Orifices internal.
Fig. 31. *Triphyllozoon patens* n. sp. (p. 603). — Torres Straits, 19. Mus. Cambr. Orifices internal.
Fig. 32. *Triphyllozoon trifoliatum* n. sp. (p. 611). — 279. A, Stat. 250. Orifices external.
Fig. 33. *Triphyllozoon indivisum* n. sp. (p. 614). — 346. A, Stat. 213. Basal view.
Fig. 34. " " " — Same locality. Side view of a stalked, saucer-shaped colony.
Fig, 35. *Triphyllozoon mucronatum* (Busk) (p. 620). — 90. A, Stat. 117. Incomplete, orifices internal.
Fig. 36. *Triphyllozoon patulum* n. sp. (p. 626). — 187. A, Stat. 267. Fragment, basal view.
Fig. 37. *Triphyllozoon tuberculiferum* n. sp. (p. 624). — 79. D, Stat. 105. Fragments, basal view.
Fig. 38. *Triphyllozoon separatum* n. sp. (p. 629). — 111. F, Stat. 156. Fragment, basal view.
Fig. 39. *Triphyllozoon bimunitum* (Ortmann) (p. 616). — 184. A, Stat. 260. On a Serpulid tube, basal view.



H. G. Herring photogr.

PLATE XXXVI.

Initial stages of colony. — *Iodictyum.*

Fig. 1. *Triphyllozoon hirsutum* (Busk) (p. 594). — 544. F, Stat. 273. Part of a young colony consisting of the ancestrula and 9 other zooecia. *A*, ancestrula. Obj. A.

Fig. 2. *Iodictyum projectum* n. sp. (p. 550). — 388. E, Stat. 81. A complete colony, probably belonging to this species. *A*, ancestrula; *M. d*, marginal denticles; *M. t*, marginal teeth; *S. d*, sinus-denticles. Obj. A.

Fig. 3. „ „ „ — Same slide. Central part of a slightly older colony. *A*, ancestrula. Obj. A.

Fig. 4. *Iodictyum phoeniceum* (Busk) (p. 541). — Adelaide, Sir J. C. Verco Coll. Mus. Cambridge. Central part of a colony consisting of about 21 zooecia. *A*, ancestrula. Obj. A.

Fig. 5. *Iodictyum polycrenulatum* (Okada) (p. 556). — 459. O, Stat. 81. Central part of a young colony about 7 mm. across. *A*, the presumed ancestrula. Obj. A.

Fig. 6. *Iodictyum phoeniceum* (Busk) (p. 541). — Bass Strait, from the type-colony, Brit. Mus., 99. 7. 1. 69. Basal surface. Obj. a^2.

Fig. 7. „ „ „ — Same slide. Zooecia, avicularia and young ovicells. Obj. A.

Fig. 8. „ „ „ — Same slide. Stages (*a*—*d*) in the development of the ovicell. See p. 542. Obj. A.

Fig. 9. „ „ „ — Another slide, from the same colony, Operculum (*O*) and two frontal mandibles (*M*). Obj. DD.

Fig. 10. *Iodictyum projectum* n. sp. (p. 550). — 247. B^4, Stat. 310. 2 mandibles (*M*) and operculum (*O*). Obj. DD.

Fig. 11. „ „ „ — 247. B^1, same Station. Zooecia and ovicell. Obj. A.

Fig. 12. „ „ „ — 271. A^4, Stat. 60, 303. Two opercula (*O*) and two mandibles (*M*). Obj. DD.

Fig. 13. „ „ „ — 271. A^1, same Station. Zooecia and ovicell. Obj. A.

Fig. 14. „ „ „ — Same slide as fig. 11. Basal surface. Obj. a^2.

Fig. 15. „ „ „ — Same slide as fig. 13. Zooecia and fenestra. Obj. A.

Fig. 16. *Iodictyum willeyi* n. sp. (p. 544). — Lifu, Loyalty Is, Mus. Cambridge, Willey Coll., slide A. Young zooecia, showing *M. V*, marginal valleys; *S. R*, septal ridges; *V. Av*, vicarious fenestral avicularium. Obj. A.

Fig. 17. „ „ „ — Same slide. Zooecia and ovicells. Obj. A.

Fig. 18. „ „ „ — Same material, 8. Basal surface. Obj. a^2.

Fig. 19. „ „ „ — Same slide. Zooecia, one frontal and two fenestral avicularia. Obj. A.

Fig. 20. „ „ „ — Same slide. Zooecia and large frontal avicularium. Obj. A.

Fig. 21. „ „ „ — Same material, 4. Two opercula (*O*) and three mandibles; *Fr. M*, frontal mandible; *Fen. M*, fenestral mandibles. Obj. DD.

Fig. 22. „ „ „ — Port Jackson, Mus. Cambridge, Jelly Coll., slide A. Zooecia and frontal avicularia. Obj. A.

Fig. 23. „ „ „ — Same slide. Zooecia and ovicells, one with a frontal vacuity. Obj. A.

Fig. 24. „ „ „ — Same material, slide B. Basal surface, showing many secondary kenozooecia. Obj. a^2.

Fig. 25. *Iodictyum deliciosum* nom. nov. (p. 554). — Japan, Mus. Cambridge, Owston Coll. 44. A^1. Zooecia and ovicell. Obj. A.

Fig. 26. „ „ „ — Same slide. Zooecia and frontal avicularia. Obj. A.

Fig. 27. „ „ „ — Same material, A^3. Two opercula (*O*) and two frontal mandibles (*M*). Obj. DD.

Fig. 28. „ „ „ — Same slide as figs 25, 26. Basal surface. Obj. a^2.

Fig. 29. *Iodictyum willeyi* n. sp. (p. 544). — Same material as figs 22—24, slide C. Three opercula (*O*), two frontal mandibles (*Fr. M.*) and two fenestral mandibles (*Fen. M.*) Obj. DD.

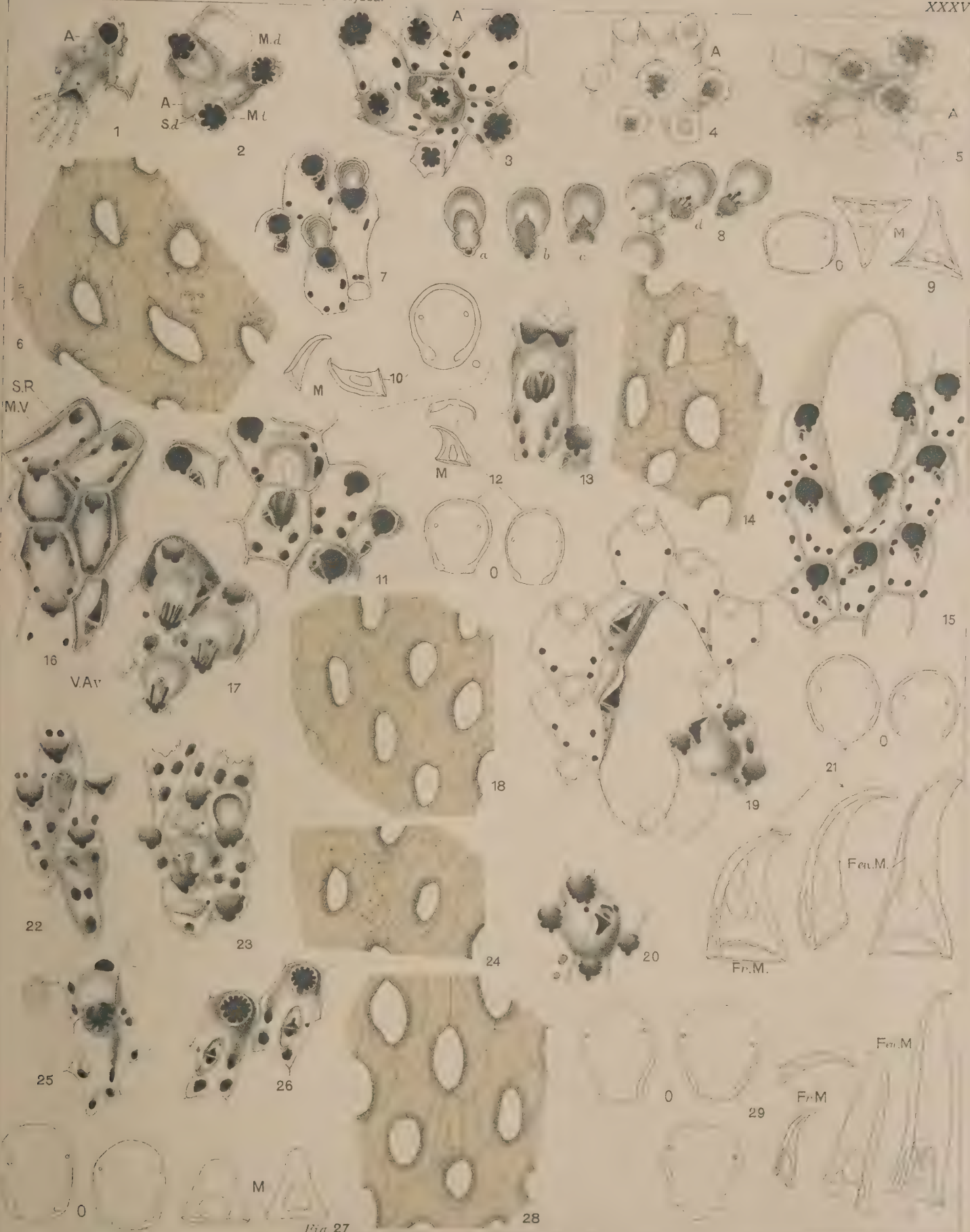


Fig. 27

S. F. Harmer del. P. J. Mulder en Zn., impr.

PLATE XXXVII.

Iodictyum.

Fig. 1. *Iodictyum buchneri* n. sp. (p. 552). — 100. A^2, Stat. 131. Zooecia and vicarious infrafenestral avicularium. Obj. A.

Fig. 2. " " " — Same slide. Zooecia and ovicells. Obj. A.

Fig. 3. " " " — Same slide. Zooecia at proximal end of a fenestra. An incipient ovicell (*Ov*) is seen in the R. zooecium. Obj. A.

Fig. 4. " " " — Same slide. Basal surface. Obj. a^2.

Fig. 5. " " " — Same material, 100. A^3. Two opercula, two frontal mandibles (smaller) and infrafenestral mandible (largest). Obj. DD.

Fig. 6. *Iodictyum axillare* (Ortm.) (p. 553). — Japan, Mus. Cambridge, Owston Coll., 13. G^3. Fenestral mandible and two opercula. Obj. DD.

Fig. 7. " " " — Same material, 13. G^1. Young zooecia. The R. one shows the frontal ends of the sinus-ridges defining the sinus-groove which descends on the inner wall of the peristome to the proximal border of the operculum. Obj. A.

Fig. 8. " " " — Same slide. Zooecia and frontal avicularia. Obj. A.

Fig. 9. " " " — Same slide. Zooecia and vicarious infrafenestral avicularium. Obj. A.

Fig. 10. *Iodictyum sanguineum* (Ortm.) p. 546). — Torres Straits, slide 4. Mus. Cambridge. Two opercula and infrafenestral mandible. Obj. DD.

Fig. 11. " " " — Torres Straits, Brit. Mus., 90. 3. 24. 89. Basal surface. Obj. a^2.

Fig. 12. " " " — China Sea, Brit. Mus., 92. 1. 28. 109. Fenestra with distal, acute avicularia, basal view. Obj. A.

Fig. 13. " " " — Japan, Brit. Mus., 83. 8. 17. 3. Two opercula and two frontal mandibles. Obj. DD.

Fig. 14. " " " — Same slide as fig. 11. Vicarious infrafenestral avicularium. Obj. A.

Fig. 15. " " " — Same slide. Zooecia, ovicells and frontal avicularium. Obj. A. (Text-fig. 27, p. 522, is a diagrammatic representation of this specimen).

Fig. 16. " " " — Same material as fig. 12. Zooecia, ovicell and frontal avicularia. Obj. A.

Fig. 17. *Iodictyum spicatum* n. sp. (p. 555). — Torres Straits, Brit. Mus. 33. 11. 10. 1. Zooecia, ovicell and frontal avicularium. Obj. A.

Fig. 18. " " " — Same slide. Young zooecia and frontal avicularia. Obj. A.

Fig. 19. *Iodictyum perarmatum* n. sp. (p. 561). — 111. E^4, Stat. 156. 2 opercula (*a*, *b*), oval avicularium (*c*), infrafenestral mandible (*d*), frontal mandibles (*e*, *f*). Obj. DD.

Fig. 20. " " " — Same material, 111. E^2. Zooecia, frontal avicularia and vicarious infrafenestral avicularium. Obj. A.

Fig. 21. " " " — Same slide. Basal surface. Obj. a^2.

Fig. 22. " " " — Same material, 111. E^5. Zooecia, frontal avicularia, ovicell. Obj. A.

Fig. 23. *Iodictyum polycrenulatum* (Okada) (p. 556). — 108. X^1, Stat. 144. Zooecia and ovicell. Obj. A.

Fig. 24. " " " — Same slide. Zooecium, labial avicularium and ovicell. Obj. A.

Fig. 25. " " " — 79. B^1, Stat. 105. Peristome and labial avicularium. Obj. A.

Fig. 26. " " " — 177. D^2, Stat. 257. 2 opercula and 2 labial mandibles, the upper foreshortened, the lower in side view. Obj. DD.

Fig. 27. " " " — Same slide as figs 23, 24. Basal surface. Obj. a^2.

Fig. 28. *Iodictyum gibberosum* (Buchn.) (p. 559). — 479. A, Stat. 109. Frontal avicularium. Obj. C.

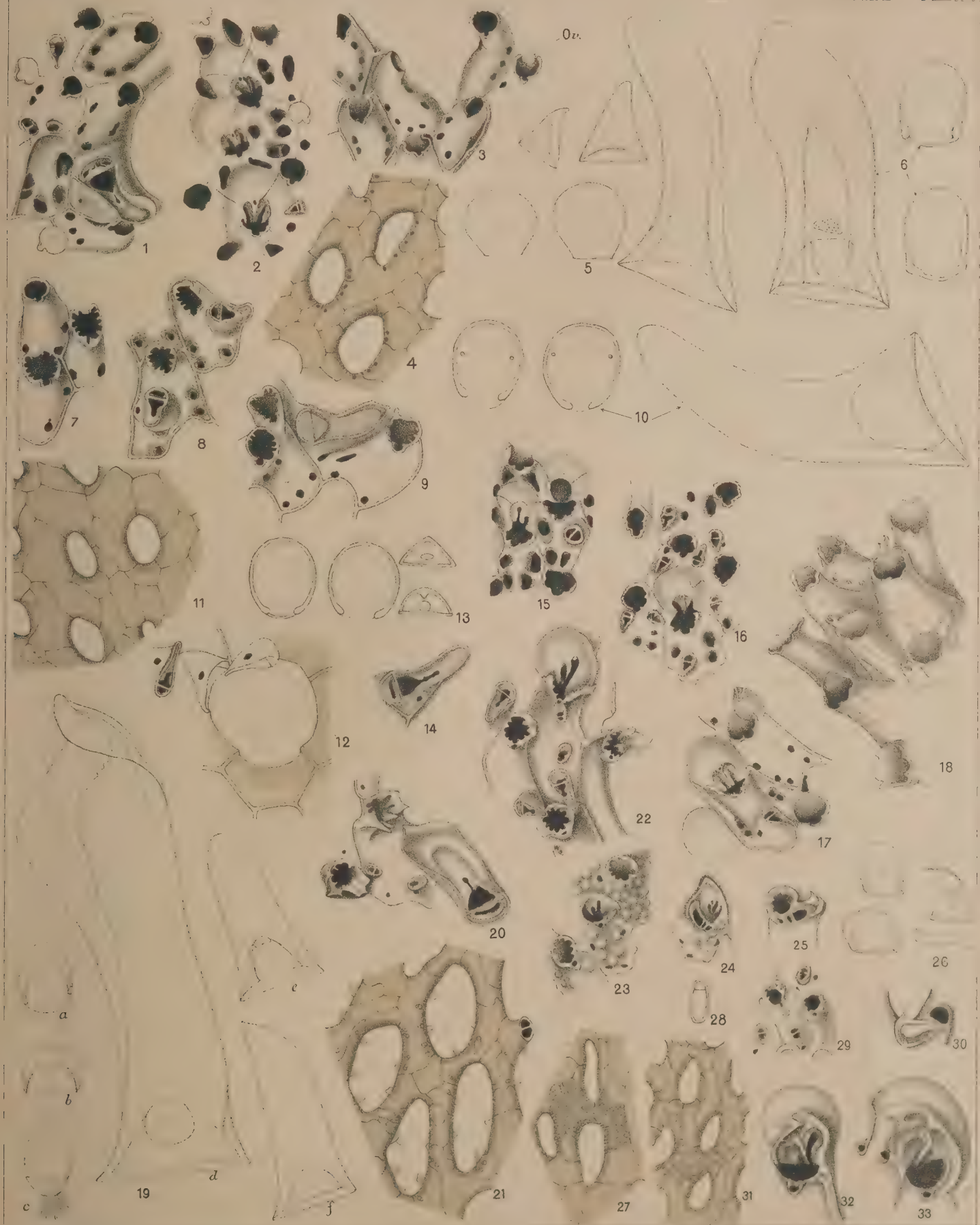
Fig. 29. " " " — Torres Straits, 14^2, Mus. Cambridge. Zooecia and frontal avicularia. Obj. A.

Fig. 30. " " " — Same material, 14^1. Infrafenestral avicularium. Obj. C.

Fig. 31. " " " — Same slide as fig. 29. Basal surface. Obj. a^2.

Fig. 32. " " " — Same slide as fig. 28. Ovicell. Obj. C.

Fig. 33. " " " — Same slide. Another ovicell. Obj. C.



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a 5 mm.

A 1 mm.

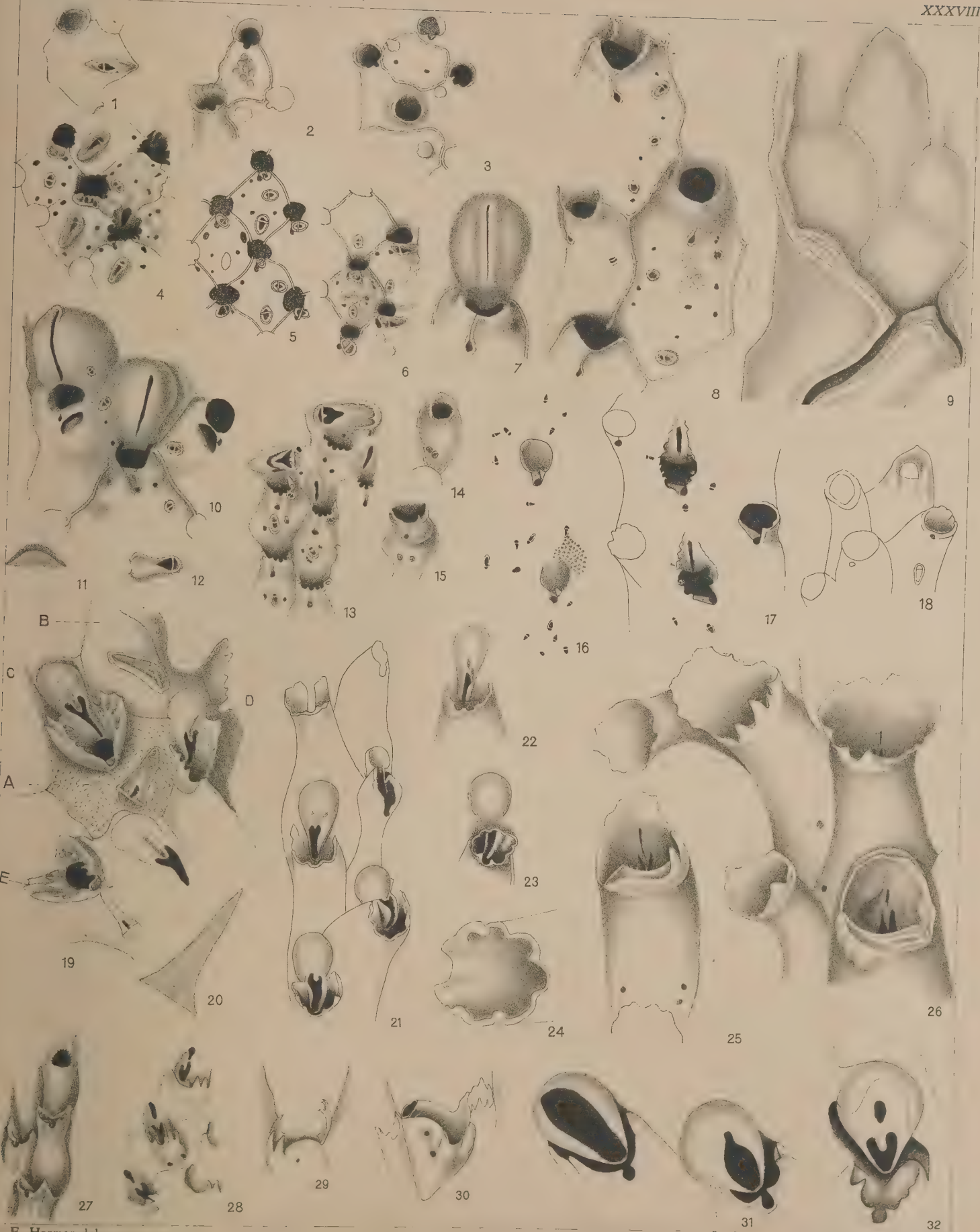
DD 0.4 mm.

C.

PLATE XXXVIII.

Sertella, Reteporella, Reteporellina.

Fig. 1. *Sertella cyclostoma* n. sp. (p. 565). — 79. F, Stat. 105. Zooecium and avicularium. Obj. A.
Fig. 2. „ „ „ — Same slide. Zooecia, one showing surface-sculpture. Obj. A.
Fig. 3. „ „ „ — Same slide. The middle orifice is that of a fertile zooecium, the ovicell being completely immersed. Obj. A.
Fig. 4. *Sertella granulata* (MacGill.) (p. 566). — 108. D^1, Stat. 144. Zooecia, avicularia and ovicells. Obj. A.
Fig. 5. „ „ „ — 33. A^2, Stat. 65. a. Zooecia and frontal avicularia. Obj. A.
Fig. 6. „ „ „ — Same slide. Showing large labial avicularia. Obj. A.
Fig. 7. *Sertella longifissa* n. sp. (p. 569). — 111. C^1, Stat. 156. Ovicell. Obj. A.
Fig. 8. „ „ „ — 111. C^2. Zooecia and frontal avicularia. Obj. A.
Fig. 9. „ „ „ — 111. C^2. Basal surface, calcined, showing laminated kenozooecia, parts of which are removed, exposing the basal surfaces of the zooecia. Obj. A.
Fig. 10. *Sertella suluensis* n. sp. (p. 570). — 83. A, Stat. 105. Ovicells, large munitiform and small round avicularia. Obj. A.
Fig. 11. „ „ „ — Same slide (dry). Munitiform mandible. Obj. C.
Fig. 12. „ „ „ — Same slide. Bicuspid avicularium. Obj. A.
Fig. 13. *Reteporella graeffei* (Kirchenp.) (p. 573). — 137. A^1, Stat. 164. Zooecia, ovicells and avicularia. Obj. A.
Fig. 14. „ „ „ — Same slide. Young zooecium with primary orifice. Obj. A.
Fig. 15. „ „ „ — Same slide. Zooecium and labial avicularium. Obj. A.
Fig. 16. *Reteporella obtecta* (Buchner) (p. 579). — 168. D, Stat. 251. Old zooecia and avicularia. Obj. A.
Fig. 17. „ „ „ — Same slide. Zooecia, ovicells and avicularia. Obj. A.
Fig. 18. „ „ „ — Same slide. Young zooecia. Obj. A.
Fig. 19. *Reteporellina capistrata* n. sp. (p. 588). — 112. K^1, Stat. 156. Zooecia, ovicell and avicularia. *A—E*, see text. Obj. A.
Fig. 20. „ „ „ — Same slide (dry). Mandible. Obj. C.
Fig. 21. *Reteporellina laxipes* (Canu and Bassler) (p. 589). — 111. J., Stat. 156. Young zooecia and ovicells. Obj. A.
Fig. 22. „ „ „ — Same slide. Young ovicell. Obj. A.
Fig. 23. „ „ „ — Same slide. Older ovicell, the peristomial orifice secondarily tubular. Obj. A.
Fig. 24. „ „ „ — Same slide. Ordinary peristome. Obj. C.
Fig. 25. *Reteporellina idmoneoides* n. sp. (p. 585). — 112. C, Stat. 156. Zooecium, ovicell and bicuspid labial avicularium. Obj. A.
Fig. 26. „ „ „ — Same slide. Zooecia, ovicells, labial avicularium. Obj. A.
Fig. 27. *Reteporellina denticulata* (Busk) (p. 581). — 9. B^1, Stat. 33. Young zooecia, the distal one showing the primary orifice. Obj. A.
Fig. 28. „ „ „ — Same slide. Older zooecia, ovicells and bicuspid avicularia. Obj. A.
Fig. 29. „ „ „ — Same slide. Infrafenestral avicularium. Obj. A.
Fig. 30. „ „ „ — 353. E, Stat. 240. Infrafenestral avicularium and two peristomes. Obj. A.
Fig. 31. „ „ „ — 9. B^1, Stat. 33. Immature ovicells. Obj. C.
Fig. 32. „ „ „ — 286. C, Stat. 33. Older ovicell. Obj. C.



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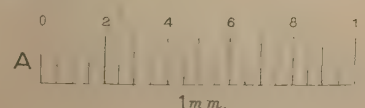


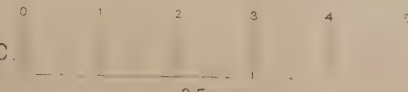
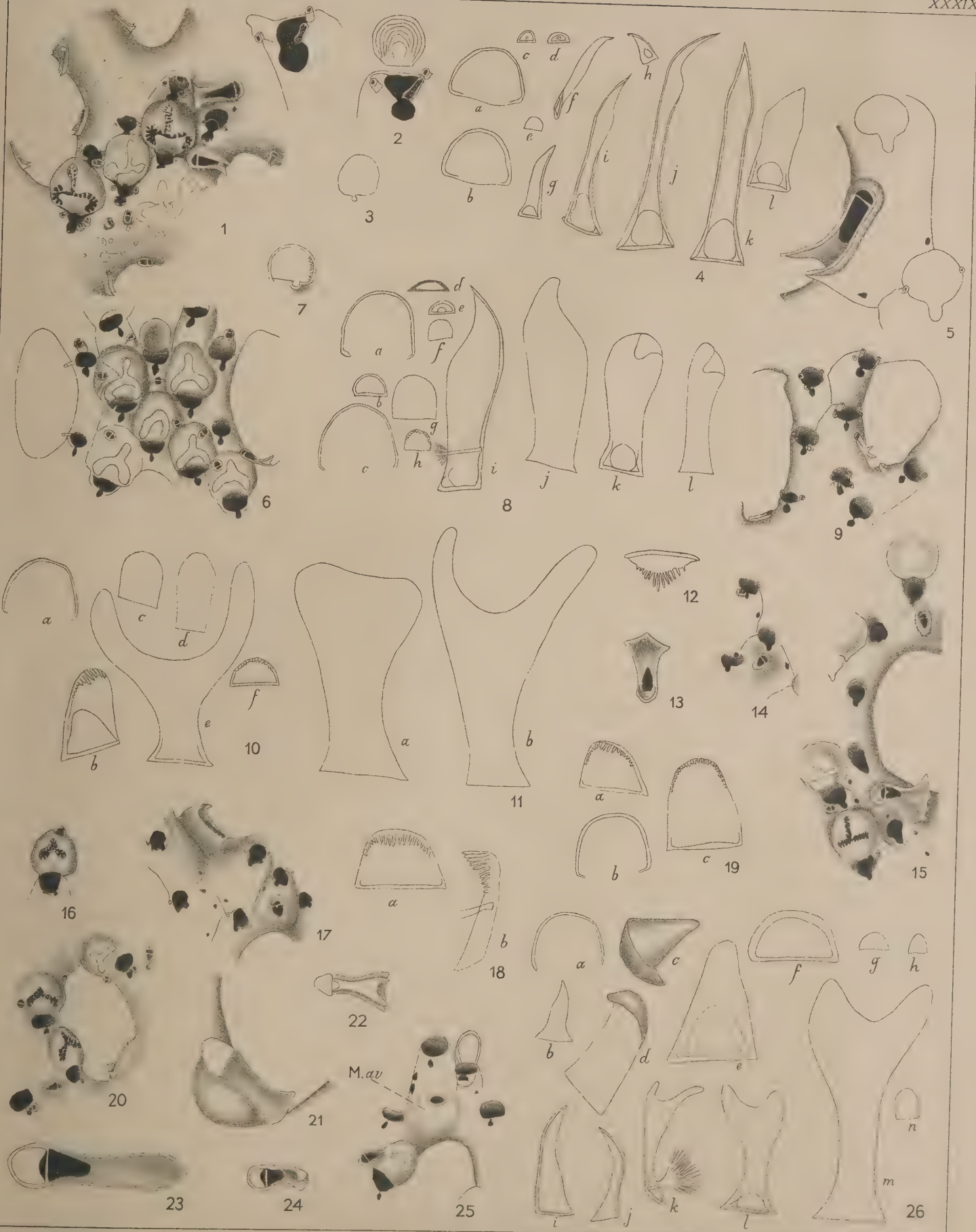


PLATE XXXIX.

Triphyllozoon.

Fig. 1. *Triphyllozoon hirsutum* (Busk) (p. 594). — 193. C^1, Stat. 274. Zooecia, ovicells, avicularia. Obj. A.
Fig. 2. " " " — Same slide. Peristomes with acute labial avicularia and a young ovicell. Obj. C.
Fig. 3. " " " — 133. F^1, Stat. 164. Primary orifice. Obj. C.
Fig. 4. " " " — 193. C^2, Stat. 274; *a*, *b*, opercula; *c*—*l*, mandibles; — *c*, *d*, small round frontal; *e*, *h*, labial; *f*, *g*, fenestral; *i*, *j*, *k*, acute frontal; *l*, wider frontal. Obj. DD.
Fig. 5. *Triphyllozoon philippinense* (Busk) (p. 597). — 65. A^1, Stat. 99. Infrafenestral avicularium. Obj. C.
Fig. 6. " " " — Same slide. Zooecia, ovicells. Obj. A.
Fig. 7. " " " — 61. A^3, Stat. 99. Primary orifice. Obj. C.
Fig. 8. " " " — 65. A^2, Stat. 99; *a*, *c*, opercula; *b*, *d*—*l*, mandibles; *b*, labial; *d*—*f*, frontal; *g*, oval, basal; *h*, round, basal; *i*, frontal or fenestral; *j*—*l*, fenestral. Obj. DD.
Fig. 9. " " " — 67. G^1, Stat. 99. Zooecia and infrafenestral avicularia. Obj. A.
Fig. 10. *Triphyllozoon tubulatum* (Busk) (p. 600). — 337. C^2, Stat. 71; *a*, operculum; *b*—*f*, mandibles; *b*, frontal; *c*—*d*, oval fenestral, frontal; *e*, infrafenestral; *f*, round, frontal. Obj. DD.
Fig. 11. " " " — 297. B^2, Stat. 273. Basal infrafenestral mandibles. Obj. DD.
Fic. 12. " " " — Same slide. Frontal mandible, seen from distal end. Obj. DD.
Fig. 13. " " " — 337. C^1, Stat. 71. Large basal avicularium. Obj. A.
Fig. 14. " " " — 317. A^1, Stat. 50. Young zooecia. Obj. A.
Fig. 15. " " " — 337. C^1, Stat. 71. Ovicells, suprafenestral and infrafenestral avicularia. Obj. A.
Fig. 16. *Triphyllozoon patens* n. sp. p. 603). — Mus. Cambridge, Torres Straits, 19^2. Ovicell and primary orifice. Obj. A.
Fig. 17. " " " — *Ibid.* Torres Straits, 215^1. Infrafenestral and suprafenestral avicularia, zooecia. Obj. A.
Fig. 18. " " " — Torres Straits, 215^2. Frontal mandibles (*a*, *b*). Obj. DD.
Fig. 19. " " " — Torres Straits, 19^4; *a*, *c*, frontal mandibles; *b*. operculum. Obj. DD.
Fig. 20. *Triphyllozoon benemunitum* nom. nov. (p. 605). — 300. A^1, Stat. 273. Zooecia, ovicells. Obj. A.
Fig. 21. " " " — Same slide. Infrafenestral avicularium. Obj. C.
Fig. 22. " " " — 300. A^2. Basal avicularium with bifid mandible. Obj. A.
Fig. 23. " " " — Mus. Cambridge. Torres Straits, 19. A^1. Basal acute avicularium. Obj. C.
Fig. 24. " " " — Same slide. Bicuspid frontal avicularium. Obj. C.
Fig. 25. " " " — Same slide. Zooecia, ovicell, suprafenestral munitiform avicularium, *M. av.* Obj. A.
Fig. 26. " " " — 300. A^3, Stat. 273 (*l* and *n* from 300. A^4); *a*, operculum; *b*—*n*, mandibles; *b*, frontal; *d*, vertically ascending lateral fenestral; *c*, another, seen from distal end; *e*, large basal; *f*, suprafenestral munitiform, frontal; *g*, small round, frontal; *h*, labial; *i*, suprafenestral; *j*, infrafenestral, acute; *k*, *l*, infrafenestral bifid, frontal; *m*, bifid, basal; *n*, oval. Obj. DD.



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A. 0 2 4 6 8 1 — 1 m m.

C. 0 1 2 3 4 5 — 0.5 m m.

DD. 0 1 2 3 4 — 0.4 m m.

PLATE XL.

Triphyllozoon.

Fig. 1. *Triphyllozoon inornatum* nom. nov. (p. 608). — 297. F^2, Stat. 273. Fenestra, etc. *H. o*, orifice of Hydroid tube; *M. av*, munitiform suprafenestral avicularium; *S. av*, characteristic fenestral avicularium, foreshortened. Obj. A.

Fig. 2. " " " — Same slide. Ovicells, etc. *M. av*, *S. av*, as in fig. 1; *H*, Hydroid orifice and tunnel, partly an unclosed groove. Obj. A.

Fig. 3. " " " — 24. A^2, Stat. 53; *a*, characteristic fenestral avicularium (decalcified), with the associated operculum; *b*, operculum; *c—g*, mandibles; *c*, frontal; *d*, basal; *e*, *f*, labial; *g*, small round frontal. Obj. DD.

Fig. 4. " " " — 410. B^2, Stat. 305; *a*. operculum; *b—e*, mandibles; *b*, infrafenestral, bifid; *c*, fenestral (characteristic type); *d*, suprafenestral, basal; *e*, labial. Obj. DD.

Fig. 5. *Triphyllozoon trifoliatum* n. sp. (p. 611). — 281. D^1, Stat. 43. Ovicells and spike-like avicularia. Obj. A.

Fig. 6. " " " — 281. D^3. Infrafenestral avicularium, its palate sloping basally and much foreshortened. Obj. C.

Fig. 7. " " " — 121. A^1, Stat. 164. A similar avicularium (cusps injured since drawing was made). Obj. A.

Fig. 8. " " " — 20. F, Stat. 50. Young peristome and spine-bases. Obj. C.

Fig. 9. " " " — 281. D^2; *b*, *c*, opercula; *a* and *d—i*, mandibles; *a*, frontal, on ovicell; *d*, *f*, labial; *e*, frontal; *g*, *h*, infrafenestral, trifoliate; *i*, oval, frontal. Obj. DD.

Fig. 10. *Triphyllozoon indivisum* n. sp. (p. 614). — 346. A^4, Stat. 213; *b*, *c*, opercula; *a*, *d*, fenestral trifoliate mandibles; *e*, small round frontal. Obj. DD.

Fig. 11. " " " — 346. A^3. Zooecia, ovicells and fenestral avicularia. Obj. A.

Fig. 12. " " " — Same slide. Peristomes, older than those of text-fig. 40 (p. 615). Obj. C.

Fig. 13. *Triphyllozoon mucronatum* (Busk) (p. 620). — 279. F^1, Stat. 250. Zooecia and avicularia. *H*, Hydroid orifice and groove. Obj. A.

Fig. 14. " " " — 483. A^1, Stat. 117. Fenestrae with large suprafenestral avicularium (*b*) and others (*c*) with slightly serrate rostra. Obj. A.

Fig. 15. " " " — Same slide. Young ovicell, the stigma incomplete, proximal frontal wall broken on left side. *H*, Hydroid orifice. Obj. A.

Fig. 16. " " " — 483. A^2; *a*, operculum; *b*, oval mandible; *c*, fenestral. Obj. DD.

Fig. 17. " " " — 90. A^3, Stat. 117. Ovicells. *H* as in fig. 15. Obj. A.

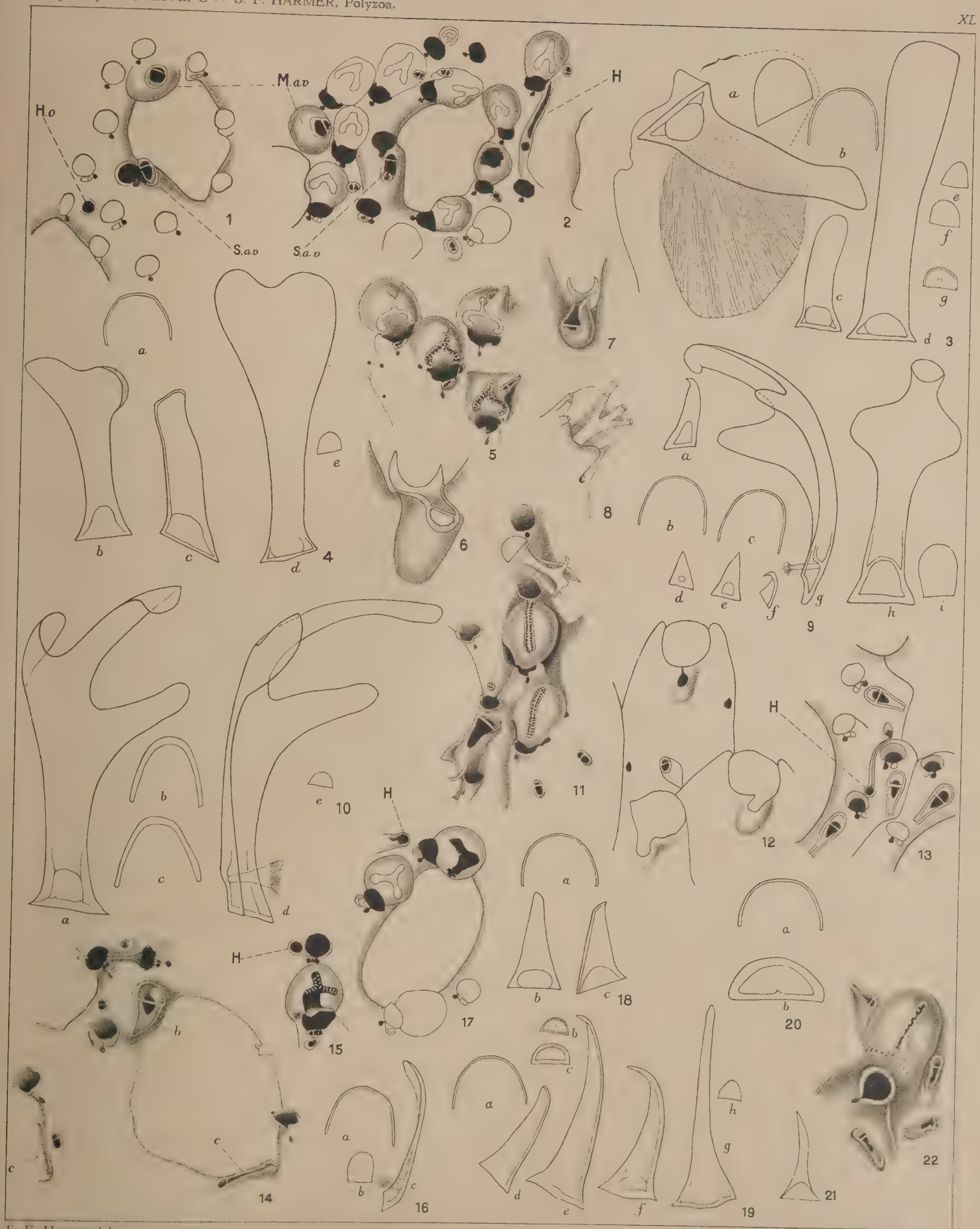
Fig. 18. " " " — 133. A^2, Stat. 164; *a*, operculum; *b*, *c*, frontal mandibles. Obj. DD.

Fig. 19. " " " — 279. F^2, Stat. 250; *a*, operculum; *b—h*, mandibles; *b*, small round, frontal; *c*, *ibid.*, submunitiform; *d*, frontal; *e*, *f*, fenestral; *g*, basal; *h*, labial. Obj. DD.

Fig. 20. " " " — 177. H^2, Stat. 257; *a*, operculum; *b*, munitiform mandible. Obj. DD.

Fig. 21. *Triphyllozoon separatum* n. sp. (p. 629). — 111. F^1, Stat 156. Fenestral mandible (from dry slide). Obj. C.

Fig. 22. " " " — Same slide. Ovicell, avicularia. Obj. A.



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P. J. Mulder en Zn., impr.

A 0 2 4 6 8 1 — 1 m.m.

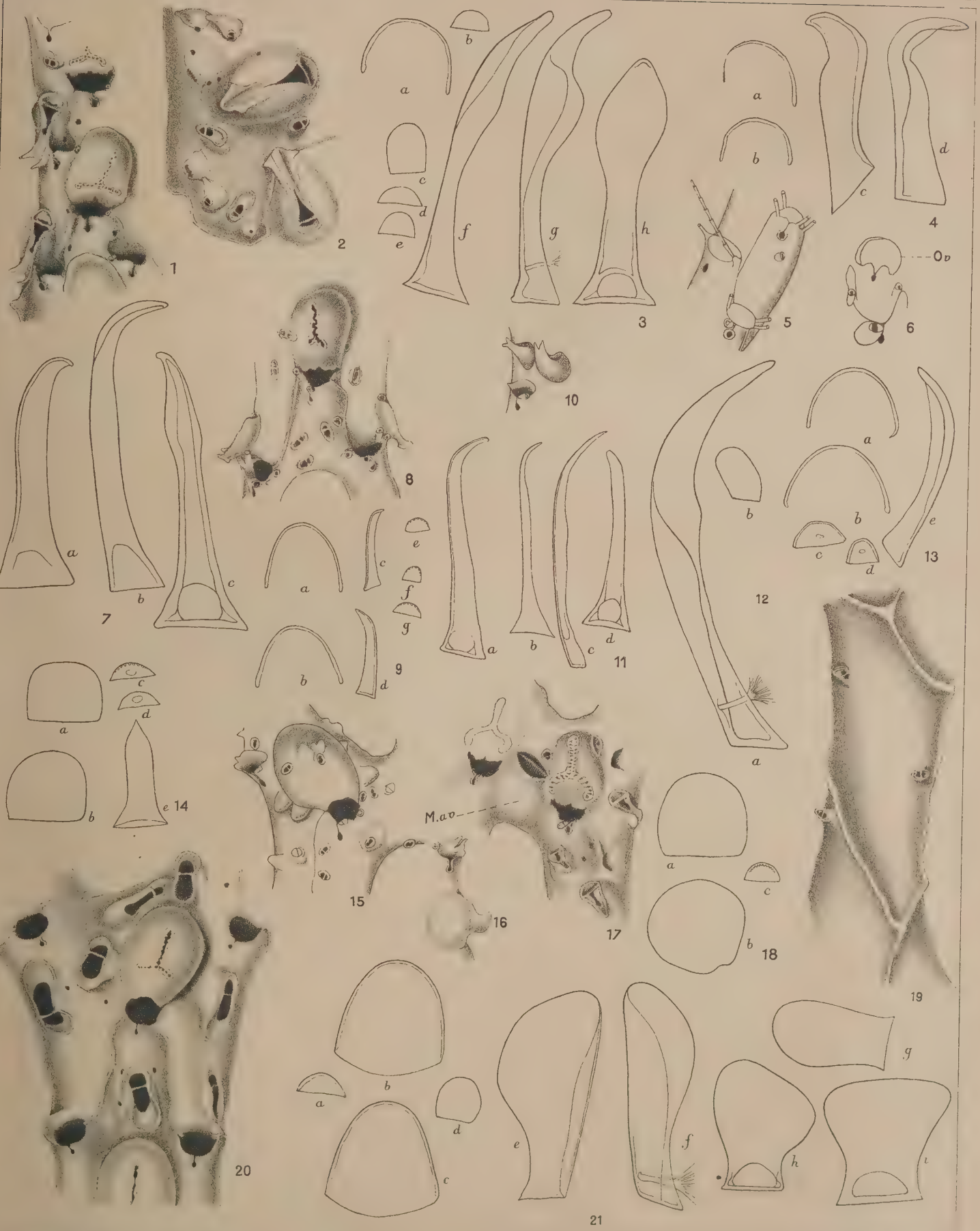
C. 0 1 2 3 4 5 — 0.5 mm

DD. 0 1 2 3 4 — 0.4mm

PLATE XLI.

Triphyllozoon.

Fig. 1. *Triphyllozoon bimunitum* (Ortm.) (p. 616). — 184. A^2, Stat. 260. Zooecia, ovicells, avicularia. Obj. A.
Fig. 2. „ „ „ — Same slide. Basal surface. Obj. A.
Fig. 3. „ „ „ — 184. A^3; *a*, operculum; *b—h*, mandibles; — *b*, labial; *c*, oval; *d*, *e*, round, basal; *f—h*, fenestral. Obj. DD.
Fig. 4. „ „ „ — Mus. Cambridge, Japan, 5. W^2; *a*, *b*, opercula; *c*, *d*, fenestral mandibles. Obj. DD.
Fig. 5. „ „ „ — 144. A^1, Stat. 166. Young zooecia. Obj. A.
Fig. 6. „ „ „ — 111. G^1, Stat. 156. Orifice of peristome with very young ovicell (*Ov*). Obj. C. (See p. 524).
Fig. 7. „ „ „ — 108. B^2, Stat. 144. Mandibles; *a*, fenestral; *b*, probably basal; *c*, probably fenestral. Obj. DD.
Fig. 8. „ „ „ — 111. G^1, Stat. 156. Zooecia, ovicells, avicularia. Obj. A.
Fig. 9. *Triphyllozoon tuberculiferum* n. sp. (p. 624). — 79. C^3, Stat. 195; *a*, *b*, opercula, *c—g*, mandibles; — *c*, basal; *d*, probably fenestral; *e*, labial; *f*, *g*, round. Obj. DD.
Fig. 10. „ „ „ — 79. C^1. Nearly vertical frontal avicularia. Obj. A.
Fig. 11. *Triphyllozoon bimunitum* (Ortm.) (p. 616). — 111. G^2, Stat. 156; *a—d*, fenestral mandibles. Obj. DD.
Fig. 12. „ „ „ — 144. A^2, Stat. 166. Mandibles; — *a*, fenestral; *b*, oval, seen obliquely. Obj. DD.
Fig. 13. „ „ „ — 112. F^2, Stat. 156; *a*, *b*, opercula; *c—e*, mandibles; — *c*, *d*, round; *e*, fenestral. Obj. DD.
Fig. 14. *Triphyllozoon tuberculiferum* n. sp. (p. 624). — 79. D^3, Stat. 105; *a*, *b*, opercula; *c—e*, mandibles; — *c*, *d*, round; *e*, acute, probable frontal. Obj. DD.
Fig. 15. „ „ „ — 111. L^1, Stat. 156. Zooecia, ovicell, avicularia. The stigma of the ovicell is occluded. Obj. A.
Fig. 16. „ „ „ — 478. B, Stat. 107. Zooecium and marginal avicularium. Obj. A.
Fig. 17. „ „ „ — Same slide. Zooecia, ovicell, avicularia; *M. av*, munitiform suprafenestral avicularium. Obj. A.
Fig. 18. *Triphyllozoon punctiligerum* (Ortm.) (p. 627). — Mus. Cambridge, Japan, 63. G^2; *a*, *b*, opercula; *c*, small round mandible. Obj. DD.
Fig. 19. *Triphyllozoon patulum* n. sp. (p. 626). — 187. A^1, Stat. 267. Basal surface. Obj. A.
Fig. 20. „ „ „ — Same slide. Zooecia, ovicells, avicularia. Obj. A.
Fig. 21. „ „ „ — 187. A^3; *b*, *c*, opercula; *a* and *d—i*, mandibles; — *a*, round; *d*, oval; *e—i*, fenestral or frontal. Obj. DD.



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A 1 mm.

C. 0.5 mm.

DD. 0.4 mm.

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